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No. 38 1924-25

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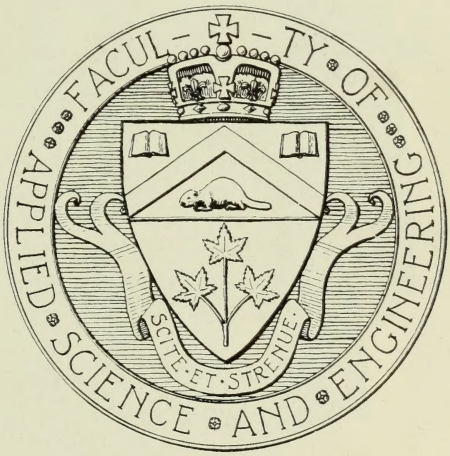
The Transactions

of the

University of Toronto Engineering Society

With which is incorporated the APPLIED SCIENCE



PUBLISHED BY THE SOCIETY

THE LITTLE RED SCHOOL HOUSE

Contents

Engineering Activities and Prospects in Canada To-day 13
DEAN MITCHELL

Town Planning 19
HORACE L. SEYMOUR

Engineering on Pacific Coast 20
DR. W. F. DURANT ....

Promotion of Engineering Education 23
W. E. WICKENDEN

Nitrates and Their Production 26
PROF. J. W. BAIN

Steam Accumulators as a Factor in Power Costs..... 31
ALFRED J. T. TAYLOR, A.S.M.E.

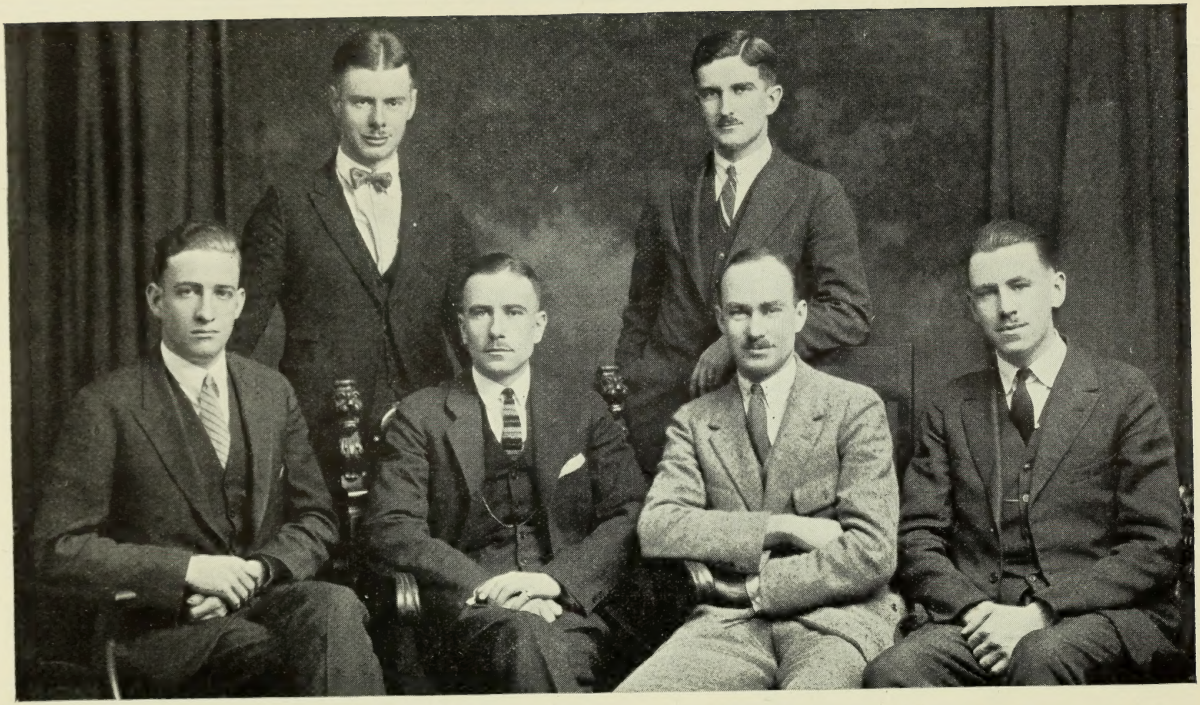
Protective Legislation 41
PROF. H. E. T. HAULTAIN

Presentation to Society of Complete Reports of Gregory Commission 44

Sudden Short Circuit Phenomena 47
ARTHUR H. FRAMPTON

Hydro Power Resources 57
T. M. PATTERSON

School Year Book 95



Standing: D. C. Beam (Secretary-Treasurer), C. W. Dillane (Associate Editor).
Sitting: S. M. Jones (Assistant Editor), W. R. Chowen (Editor-in-Chief), C. W. Gordon (Associate Editor), J. Lindsay (Business-Manager).

Transactions and Year Book

of the

University of Toronto Engineering Society

With which is incorporated "Applied Science"

PUBLISHED ANNUALLY BY THE SOCIETY

No. 38 TORONTO, APRIL 15, 1925 Price 50c.

W. Roy Chowen - - - - - *Editor-in-Chief*

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C. W. Dillane
Associate Editor

C. G. Gordon
Associate Editor

J. Lindsay
Business Manager

D. C. Beam
Secretary-Treasurer

Editorial

The "Transactions and Year Book of the Engineering Society" as the official organ of that Society, has seemingly come to stay, in so far as its present form is concerned, at least. Indulging in a little retrospection of the history of this volume one is struck with the appearance of evolution. But evolution is a slow process and at best merely represents the work of chance or conditions existing at each step. It is not to be supposed that evolution in this case means an advancement in perfection. We fondly hope it does. Indeed in our less rational moments we feel that this, the product of our earnest and concentrated endeavours, could not be otherwise. But always there comes the cruel pitiless light of saner perception, and so with befitting humility we offer you this, the fifth issue of "Transactions" as an Annual.

You will find one section missing, that of the "Old School." To run another ten years would almost encroach on our own days here, and interest might flag.

The addresses given before the Engineering Society occupy the first part of the book and are reproduced with meticulous care. One or two of the addresses were illustrated with lantern slides and diagrams to such an extent that the address in print would be quite pointless without them. Thus we have been compelled to leave them out. A few other papers are included in this section,

which are explained by footnotes, and for these papers we owe a debt of gratitude to the authors. The second and last part of the book is more pertinently "School." In brief it is our Year Book, and as such constitutes another page in the history of our Faculty. To the undergraduate it presents, in permanent form, a record of his interests during one of his years here. To the graduate it forms a connecting link with his beloved "School" and keeps ever before him her progress, in realms which once took such heavy toll of his own time and enthusiasm.

And so we give you "Transactions." May you find in reading it some of the spirit of untiring energy and unselfish effort of those men who, by their activities here, made it possible for the Board in our role of historians to compile such a volume.

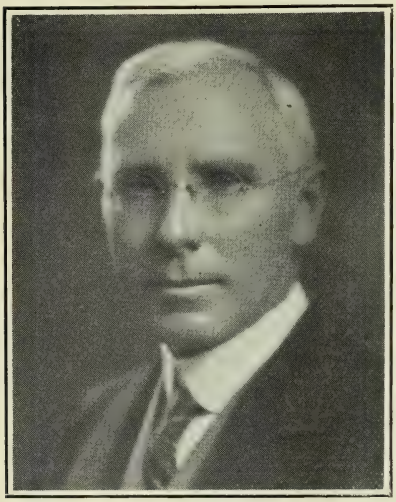
Service

Perhaps the most prevalent trait of character amongst students is that something which makes him say to himself, "I will not be a servant, I will climb to great heights where others will serve me."

There was once a man who decided on exactly this course, so he began by studying the life of the foreman under whom he worked in order that he might qualify for this position. Presently he was promoted to such a position only to find that he must take orders from a whole staff of higher officials. Undaunted he aspired to the office of superintendent, and later to general manager, but here again he was made responsible to practically the entire executive.

Mystified he decided to consult the president of the company. While attempting to interview him, several days were lost simply because the president was too busy looking after the people on whom he depended, to even see him for a few minutes. When this was made known to the young man, he was very puzzled for he knew the president to be the head of an extraordinarily large and prosperous corporation. He said to himself, "I will go to the Prime Minister of the land," for surely he of all people will be independent. During the resulting interview, they were continually interrupted by messengers carrying communication to and from the Prime Minister. "Who are these?" inquired the young man. "They carry messages to all parts of the land to appease the troubles of the people," was the answer. Then the young man had a bright idea and he said, "I will leave off trying to avoid service and serve as many as I can, for the number of people whom a man serves is a measure of his success."

The Dean's Message of 1925



The present year of the Engineering Society has been one of considerable progress and the types and quality of the papers and addresses given before it have been of a high order. I wish to congratulate the President and officers of the Society upon their efforts.

I wish also to congratulate the undergraduates and especially the year now graduating, in being here at this time. Those who are about to leave, and those who shortly will follow, will go out into the world at a time when they will be ready for taking advantage of the progress and the renewal of engineering activity which appear to be not very far distant.

The Engineering Society through the papers and addresses which have been presented, has afforded an opportunity for development apart from the purely academic. If graduates and undergraduates alike, carry this principle out with them, of broadening their general education and making the best use of all facilities to continually acquire engineering and other knowledge, they will progress in their profession well equipped for what they may be called upon to do.

Wishing all the members of the Engineering Society continued success.

(Sgd.) C. H. Mitchell,
Dean.

Address of Retiring President

GENTLEMEN:

Having all but completed our year's work this seems to be a very fitting time to give a résumé of the term's activities.

The regular meetings of the Engineering Society, addressed by some noted and able speakers, have been carried through without a break. The attendance on the whole has been fair, but might have been considerably better if the members took the interest in the Society's affairs which they should. It would appear that to have a large turnout at these meetings it is necessary to supply a sugar coating in the form of a speaker who, besides being capable, must be witty.

One item of outstanding importance at one of the last meetings was the gift by Mr. Allan Ross, in memory of Mr. Walter J. Francis, of his set of the reports of the Hydro-Electric Enquiry Commission. This gift is being placed in the Main Library, and will be open for examination as soon as the final arrangements have been made with the Librarian.

The Annual "School" Dinner in the Fall was a decided success in every way, except in attendance, as it resulted in a deficit. For the past few years this function has not received the support which it deserved, with the result that the question as to whether or not it should be dropped has become more insistent each year.

Every one who was at the Engineering Society At-Home, whether they arrived before or after one a.m., declare that it was the most enjoyable social function at Varsity this season. It is too bad that they are so costly or they might be held more often.

Thanks to the untiring efforts of a very capable manager and assistance of the club and year executives, the S.P.S. Stunt Night in Hart House lived up to the high standard set during the past two years. This year it was felt that we could not afford to put it on free of charge. A figure was set which we hoped would just cover expenses without even allowing a factor of safety.

A statement of the finances of the Society, shown elsewhere, will show how well the Supply Department has done up to the end of February. The sale of apples was a very popular innovation, but has aroused considerable dissatisfaction on account of the mess they make in the buildings. The daily sales have compared very favourably with those of last year. Our treasurer has cashed so many cheques during the term that he is beginning to think that he is a bank teller. It is very gratifying to note that nobody has taken advantage, wilfully, of this convenience, to pass off any valueless cheques.

The item this year which has caused the greatest amount of thought in connection with the Engineering Society has been finances. The overhead and general expenses have remained practically the same as formerly, while the returns from fees and profits have fallen as fast as the registration. The maintenance of the Employment Bureau, which was started for the class of 2T3, has been the chief burden. It was thought inadvisable to drop it after two years of good ground work had been put in, and that in the course of the year some new idea might come to light by which it could be run without the present financial embarrassment to the Engineering Society.

In closing, I should like to express my heartiest appreciation to the Dean and the different members of the staff for their valuable advice and assistance, and to the members of the Society's executive for their constant support and the capable way they carried out all their duties. I should also like to thank those who have given their time and energy during the term to carry out the plans of the Society, among whom are: "Jake" Tanton, who so ably managed the affairs for Stunt Night; Jim Lindsay, for his work as Editor of the *Toike Oike;* Harry Miller, for handling our section in *Torontonensis*, and many others.

(Signed) J. F. MILLICAN.

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WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

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*ENGINEERING ACTIVITIES AND PROSPECTS IN CANADA TO-DAY

By Dean C. H. Mitchell

We are inclined to look on 1924 and 1925 as dull years for the engineer, but they are and will nevertheless be years of activity. After all there is a great deal of Engineering work going on in this country.

Let us make a review and think first of the engineering in connection with basic production and with the development of our resources which enter so much into our life to-day.

Agriculture.

Starting with these one cannot help thinking immediately of agriculture. It is after all the basic industry of our country and will for decades to come be the basis of our wealth. I would like to give you two ideas on this subject. Engineering has a great deal to do with making the land more productive, and some one has said that the man who does the most for his country is he who makes two blades of grass or grain grow and yield in the place of one. Second, the farmer to-day is getting more for his grain than at any time since the war; that means much to the whole country. When we reflect on these we realize how much there is to do for the civil, mechanical and chemical engineers.

The Metals.

As to iron unfortunately we do not produce very much at this time, but we are not far away from the time when methods are going to develop for utilizing our low-grade ores.

*Address to Society, October 29, 1924.

There is a considerable activity in copper to-day in British Columbia, Manitoba, Northern Saskatchewan, Northern Ontario and Quebec. In the new Rouyn field in Quebec there has been discovered within the last year a large deposit of copper ore. That means that the great copper, gold and silver region of Ontario is extending eastward into Quebec.

In gold there is tremendous activity in various parts of Canada. In British Columbia the outstanding mine is the Premier. In Ontario, at Hollinger and at Kirkland Lake there have been enormous increases in the past two years. The new Rouyn region previously referred to is also beginning to produce gold.

We are inclined to think of the old silver and Cobalt areas of Ontario as declining. Though this may be true for the Cobalt region silver mining is continuing very active in other localities and is specially productive in the Lorraine region.

A much discussed ore in British Columbia is the complex lead and copper ore. Methods of handling it have been devised so that what a few years ago was thought to be worthless waste material is now made productive on a paying basis. So too with other large copper deposits in British Columbia. The new and very large Kimberley mill has just been built to work up these low grade ores.

Transportation.

Four years ago we were in the middle of a very difficult situation with regard to our National Railways. To-day the Canadian National Railway is on its feet. It is getting on, improving each year and the last two years have seen a steady improvement. Last year there was a great deal of discussion about the extent to which new lines should be built for the C.N.R. out west. There is and always will be a demand for new lines, in certain localities at least, and there are at present either under construction or projected, upwards of two thousand miles of new lines. Engineering in this branch is certainly picking up.

The Toronto Viaduct question has been going back and forth for many years. Now (October 1924) an agreement has at last been arrived at, and the methods, proportions of cost and other financial features being settled, the project is about to proceed. Twenty-nine million dollars worth of work will thus be done right here in Toronto.

Another activity in Transportation is the construction of the new Welland Ship Canal. This Canal is the largest piece of

engineering work going on in the world to-day; it is the second largest canal work in the world, being second to the Panama only. It is being built almost entirely by Canadian University graduates. Its object being to fit into a gigantic plan to permit ocean-going ships to go through to the head of the lakes, the locks are of sufficient size to take ships over 800 feet long, 80 feet wide and drawing 30 feet of water. The Canadian Government is spending between eighty and one hundred million dollars on it and we are living in the middle of that huge work to-day without fully realizing it.

Within the last year one of the largest dry-docks on the Atlantic Coast has been completed in New Brunswick; Montreal harbour is very busy with new work, millions having already been spent building the St. Lawrence Ship Channel from Montreal to the sea. The Government and City have already spent nearly twenty millions on the Toronto harbour, and there is half as much again yet to be spent. Vancouver is well embarked on a very large programme of harbour work; the Dominion Government having allotted five million dollars to it this year. In Victoria there will shortly be completed a dry-dock, which will be among the largest on the Pacific coast. These instances give an idea of what is happening in this branch of Engineering.

Municipal Work.

Municipal work in progress to-day does not mean so much in money or magnitude, but it means much in the employment of engineers. There still are large programmes of highway construction both being built and repaired. The City of Toronto is adding materially to its water system at the present time, planning a fifteen million duplicate main system. Ottawa is progressing towards a new and comprehensive system. Hamilton has a large project in view. Toronto has also considerable drainage work going on and there is similar activity in the Border Cities around Windsor.

Structural.

Two of the largest bridge structures on the continent are now being built in Toronto, St. Clair Ave. bridge in Moore Park and the huge viaduct on Bloor Street west. At Niagara there is just being completed another steel arch railway bridge, built by the Michigan Central Railway over the gorge above the whirlpool rapids. In Montreal there is a new bridge project which is passing

through the preliminary stages; this is the construction of a high level bridge crossing the St. Lawrence from the heart of the city to the south side of the river.

Electrical.

The Queenston-Chippewa power plant is still being added to, three more units being now in process of installation; that also means a large amount of new work in connection with this magnificent plant. Another extensive hydro-electric plant, the construction of which is just now completed, is the La Gabelle plant on the St. Maurice River, eighty miles from Montreal. The units in this are thirty thousand horse-power each under sixty feet head. They are being built by our Canadian works and Canadian engineers and represent the latest designs in both hydraulic and electrical equipment.

A good deal of activity is in progress toward heat treatment electrically. That is one of the most prolific fields of study in electrical work which during the next few years will absorb engineers. Then there is also the change of our telephone system from the manual to the automatic system; most of that work is being done by our own Canadian engineers, many of them graduates of this University.

We now begin to realize what a unique place Radio has taken in our lives to-day. Even four years ago it was quite in its infancy, and there is no telling what the next four years will bring about. The Dominion Government is doing much already in employing a number of radio engineers. As one instance of the new use to which Radio is being put we observe its application to take the place of light-houses for ocean navigation. In England they are putting up new Radio directors and by radio beams they do the work of the light beams of a light-house. This is an application which has come within the last twelve months and its introduction may not be far off in Canada.

Mechanical.

There is great activity at the present time in the development of steam turbine work. Engines are now being built that have pressures of five hundred to one thousand pounds per square inch. A new mechanical development is the introduction of the new locomotives of the Canadian National. They have over two hundred control valves and levers; stoking is mechanical; they travel thirty-five or forty miles an hour and haul seventy-five to one hundred cars.

The development of the hydraulic turbine is also entering new fields, the propeller type for low heads being especially of interest and being installed in various Canadian hydro electric plants.

Architecture.

Attention is drawn to two large sky-scraper buildings going up in Toronto to-day, one twenty stories and the other sixteen. Modern and up to date in every particular and full of mechanical and electrical equipment they represent very considerable activity in this branch of architecture. There is also the new Manufacturers' Life building on Bloor Street East, a very substantial and magnificent piece of work representing a new type of architecture in this city.

Chemical.

In Chemical Engineering, while the activities are not as numerous or perhaps as extensive as a few years ago, there is a large field. For instance there is an enormous amount of paper being made in this country. The rubber industry also absorbs many chemical engineers. There is also great activity in the paint and varnish industry and in sugar, packing-house and food products generally. There are also the tanning, dyeing and other tinctorial chemical industries. All of these show considerable activity although in a limited degree owing to restricted markets.

Prospects of the Future.

One of our great Canadian assets to-day lies in the "Precambrian Shield" geological formation to the North. It is hard to tell what a few years further exploration and development will bring forth from this rich area.

Before the war there was considerable employment in Civil Engineering but since then it has been much restricted. I believe, however, that in five years time Civil Engineers are going to be engaged in greatly increased activity and everything points to a return to large construction in due course.

Think for instance of the possibilities of the huge St. Lawrence Waterway project. You students who will then be graduates must be ready for that when it does come. You are going to be involved in work in connection with it in some form. It is hard to realize the magnitude that project will be. Besides the huge power possibilities of the St. Lawrence the navigation portion of the St. Lawrence project will be the largest thing ever attempted ex-

cluding the Panama canal. The two countries involved have recently agreed to make a complete study of the project and an International Board of Engineers is now engaged on it.

I wish to conclude by impressing on you the idea that no matter how quiet engineering prospects may appear at present, you are approaching a time, perhaps not very far distant, when great activity in all kinds of work will be resumed. I leave it with you at that.

VIEW OF ELECTRIC LAB

*TOWN PLANNING

HORACE L. SEYMOUR

I think, gentlemen, that we live in a fortunate age. I feel that we engineers are living at a better period than when I graduated. I sense this fact,—the engineers are taking a broader interest in public affairs.

There are many movements afoot in Canada and throughout the world of which the engineer should have more than the ordinary knowledge. About twenty years ago there were two such new movements in Canada; one was the good roads movement, the other the inauguration of Horticultural Societies throughout Ontario. There were many pessimists who said the roads were all right as they were, but we know what we have now. Many of our roads are the envy of our cousins to the south of us, whereas a few years ago we had to go into the States to find good roads. It was a movement in which every engineer was expected to take part or at least to give his sympathy. Regarding the Horticultural Societies, a few years ago we had 30,000 members in Ontario.

Town planning is at this time in somewhat the same situation as the other two movements. It will become something,—as we are sure now that the other two have had an effect on our country. In the States there are one or two universities which devote considerable time to town planning. The best definition of "town planning" is to show you some of the work that has been done. Planning is simply the scientific way of engaging in any art. If we plan for buildings we call it architecture, if we plan for gardens we call it landscape gardening. It includes the surveyor and most particularly the engineer. One engineer said town planning was 80% engineering. The best verbal definition I can give is "community foresight"; looking ahead by planning now to save expense in the future; the orderly arrangement of land and buildings and the utility serving them, the object, of course, being economy and better social conditions.

One phase of the subject, the spectacular phase of it, is the replanning. We probably find most interest centred on this feature.

Here slides were shown of the results of the Halifax explosion, the proposed reconstruction of the area, and of Haileybury after the fire. Mr. Seymour pointed out some of the old faults and mentioned proposed improvements. These slides were followed by a number of others showing various plans and problems, including that put forward by Sir Christopher Wren for rebuilding London after the Great Fire, concluding with a series showing replanning to relieve congestion in New York.

*Address before Society, Jan. 28, 1925.

*ENGINEERING ON PACIFIC COAST

Dr. W. F. Durand

One of the larger engineering undertakings in which we are interested on the Pacific Coast is the problem of the Colorado River. This presents a very live problem in the States and is receiving a good deal of attention in Washington, though the politicians there usually succeed in blocking what the engineers put forward.

This particular problem is quadrangular. The first angle is the protection of the inhabitants of the Colorado River Valley. This valley was a desert waste a few years ago; now it is the centre of a very populous farming community. The people have invested their all and are living under the constant menace of the river flooding. In 1905 there was a break in the bank of the river and a great deal of this territory was put under water. It cost millions of dollars to reclear this territory. In its lower reaches the Colorado River is flowing on a very slow gradient, and carries a large amount of silt. It is tending to move to one side or the other. This river is flowing through an elevated trough; before the people can control it the river breaks through and flows over the valley. The people feel that they are living under a direct menace, and they have appealed for protection from it.

Another angle is the actual existence of four million acres of territory which could be profitably irrigated by the Colorado River.

Regarding the third, those who live here, where the annual rainfall is thirty or forty inches, are not always able to realize the absolute dependence of the progress of civilization on an adequate supply of drinking water. The city of Los Angeles, some twelve or fifteen years ago, constructed an aqueduct bringing water from the mountains, aggregating a quantity to supply two million inhabitants. They thought they were adequately supplied for a long, long time, but there have been dry years, and the supply which was expected to last so long, cannot be safely depended on. The city is growing and the original supply intended for two million will not be sufficient to meet the demand. The present population is over one million; at the rate at which the city is growing, and assuming that possibly the present supply will not be adequate for 1½ or 1¾ millions, it is already time for the city to stir itself in regard to finding another source of drinking water. The only place is the Colorado River.

The fourth angle is the question of the supply of electric power. The demand for it has been increasing at a compound interest rate of somewhere between 15 and 20%. The consumption of electric power increases 4½ times as fast as the population. Los Angeles is undergoing that transformation. The very rapid increase of

*Address before Society Jan. 11, 1925.

power consumption in Los Angeles, and half as much again in surrounding smaller towns all growing at about the same rate will soon result in the present supply of power becoming entirely inadequate. Unless power does become available it is perfectly evident that the supply from our now available sources will very promptly become used up, and then we can't tell what will happen. An undertaking such as that which is contemplated in the river will take a considerable number of years to bring to a conclusion. It seems perfectly safe to count upon a consumption which will practically absorb the supply, just about the time when it will be ready for delivery. I should not, of course, leave out of account certain demands in the States of Arizona and Nevada. In Arizona power is wanted right now. Between Nevada, Arizona and California there is no doubt about the market for this power.

In what way can the river be made to meet the conditions of this problem? It flows south and west into the Gulf of California. Its total length is 1,750 miles from the head-waters of the largest stream. The average rate of flow is about 1/10 the average rate of the Niagara, but unlike the Niagara it is subject to extreme fluctuations. The total annual discharge of the river is seventeen million acre-feet. Half of this discharge might easily come during the flood period. The river carries a very large burden of silt, 80 or 90,000 acre-feet per year. This burden of silt is a very important factor in any development in this river. With regard to the protection of the Imperial Valley, it is obvious that the danger will come with the flood. If we can reduce the flow to 80 second-feet we shall have succeeded in adequately protecting the Imperial Valley. At one point on this river, where it turns and begins to flow south, the river flows through a canyon, the walls of which are 2,000 feet high. The width of the canyon at water surface, at low water, is 300 or 350 feet, widening out as the level rises. It is an ideal place for putting in a great cement plug, and thereby forming a dam. It would be something of the order of 600 feet high above mean low water level, and would go about 600 feet below. This dam would result in a reservoir, the cubic contents of which would be about 31,000,000 acre feet. As for the rate of inflow and outflow, it has been clearly shown that with a flow down the river of 60, 70 or 80 second-feet, it would be possible to accommodate 250,000 second-feet at the maximum. This dam must never be allowed to overflow.

With reference to irrigation, if we can regulate the river flow we can also regulate the discharge for irrigation. This will not happen for a long time.

In the matter of setting this reservoir. It must be a very long reservoir with a long range for stilling the water and dropping the silt. The silt will be dropped long before the water reaches the dam itself. Supplementary reservoirs could readily be provided. These provide the basic requirements for the water supply of the cities of California.

It would be possible to develop about 600,000 horse-power throughout the year, assuming that there is a market for this amount. It is expected from experience that in the power system we should be able to supply this power on a low factor, 60% of maximum. There are a lot of problems of great interest which arise in this connection, all kinds of problems of the transmission of power. If power from the river should have to be sent five or six hundred miles, it would undoubtedly require higher operating voltage. There would be no trouble in marketing the power and it would be sold at a figure attractive to users of power in large or small quantities.

Growing out of these basic problems are many smaller ones. The whole question is attracting quite a bit of attention. Hydro power represents a draft on an annual allotment given us by the sun. When we use coal and oil we are drawing on our principal, and there is only one end to the man who keeps drawing on his principal and does not replenish it. It becomes doubly important that we should see to the conservation of natural resources in order that we may extend their utilization over the longest possible period of time.

ELECTRICAL BUILDING

*PROMOTION OF ENGINEERING EDUCATION

By W. E. Wickenden

I am going to talk to you this afternoon about a big business. A business carried on at 150 different centres of production; a business which engages the nearly exclusive attention of 70,000 people; which represents a capital investment of $150,000,000. The annual expenditure going into the product of this business is somewhere near $50,000,000. You see, it's the biggest kind of a business, Engineering Education.

There are about 60,000 students and five or ten thousand teachers engaged in this business. The product? Nine thousand men who complete their courses and receive their degrees every year. However, besides this direct production there are by-products. That is one of our problems. It is perfectly plain to anybody that any business as big as this is could be run better. No business in the world is run so well that there is no need for improvement.

Education is something in which we walk almost entirely by faith and scarcely at all by sight, and those who are most entirely engaged in it must sooner or later have misgivings about it. Throughout the entire length and breadth of the business there are very real misgivings as to whether we are doing this job in the right way, or not; if those most directly concerned are the right ones for the job. We are asking ourselves, "Is this organization well set up? Have we got the right amount of balance between local initiative and general guidance? Should we locate our plants with regard to the raw material or to the market? Should our colleges be where the men are or the industries are?" It seems clear that we must take the colleges to the men, but we must still ask ourselves "Are our plants properly located,—are they getting the right kind of material to work on?"

There is a tremendous wave of enthusiasm for going to college on the American side. With a 40% increase in population between 1900 and 1920 the college attendance has quadrupled. This is most strongly marked in the agricultural rather than the industrial centres. The college-going habit has spread beyond the limits of the literary groups in society.

The public wants to know, "Do the plants have the right kind of facilities and enough of them?" Is the personnel which directs and operates these plants well selected, well trained, and is it picked by merit? Are we taking the right steps to keep it so?" We have to face that fact in Engineering Education.

We have to ask ourselves, "Does the product of this business meet the requirements of the market in kind and quantity?" Just what is the occupational demand for engineering graduates? The

*Address before Society Nov. 17, 1924.

industries are carrying on a survey of their requirements. This is what they are finding out: For men of broad general training and of promising personality and good human qualities, the absorbing power of the industrial market on this continent is very far below saturation. For men of high degrees of specialization the market supply and demand are properly balanced to-day.

We have to ask ourselves, "Ought some new requirements to be anticipated and provided for? Are there some new things that are going to develop in the industrial life of our country, and are we going to wait until the market is pounding on our doors before adjusting our education to meet the demand?"

We must ask seriously, "Are we producing as high a proportion of product as we should?" Four out of every ten who matriculate finish their course and get a degree. The rest go into the by-products. That represents a lot of waste. Perhaps the proportion is too high.

There are other questions: "Is the distribution of this product as good or as economical as it should be? Are certain industries being overfed with graduates and others being disregarded? Is the process by which we distribute good or bad? Isn't the transition between the time when some person is educating you, and when you get outside to educate yourself, rather abrupt?" That is part of the problem involved in the distribution of the product of the school, for there is no such thing as a finished education.

Let us ask ourselves, "Is the product used by the consumers as intelligently as it ought to be?" I dare say some of you have opinions on that. The better qualified and trained men are prone to assume that the fact that they are sought for places the whole burden of their success on the man who hires them. Let me warn you against it. Is society getting a fair return on the investment it is making in education? A survey has shown that it takes a college man 12 to 15 years to wipe out the four years mortgage society holds on him.

Another question, "Are we surpassing or are we barely keeping up with the progress that is being made by our competitors abroad?" This is clear,—the problem with which we are all confronted in the United States, Canada, and probably in Mexico, is the problem of more production per man. This is a continent where men are relatively scarce and materials abundant. We must have better organization of industry. But we have economic problems in connection with our materials. Are we using our coal to the best advantage? How long will the oil last? What is happening to the timber, the soil, and the water?

They are going to call on the engineer to solve all these, and for another very important service. They are going to call on him to make the spending process intelligent. This is a huge job. If it isn't the engineers, whose is it? Engineers are being called upon to bring more of the professional spirit into public life. Hoover, for

instance. And one thing more; the engineer of to-morrow has to face the problem of whether we can go on indefinitely assuming that mankind can adjust itself to civilization, or whether we can design civilization to accommodate human nature. If any of you have ever tried to ride on a New York subway at about five o'clock you will know what I mean. The men who built them calculated their loads, worked out their stresses, allowed their factors of safety, considered everything except the endurance of the people who would use them. Soon they are going to call on the engineer to adapt this civilization to humanity.

I think you are coming on the stage at a fortunate time. It is a great profession for which you are training; the profession of engineering. To-day the engineer is consciously accepting the responsibility for making civilization work, as well as building the machinery for it.

MINING BUILDING

NITRATES AND THEIR PRODUCTION

By Prof. J. W. Bain

While nitrates are found in small quantities in tropical countries, only in India are they recovered in commercial quantities. Here they are collected by very low caste natives who extract them from the highly manured soil, and by a crude refining process produce potassium nitrate or saltpeter. The amount thus brought on the world market is relatively small and may for our purpose be neglected.

In only one place in the world is there any considerable quantity of nitrates, in the northern part of Chile. You will recollect that this country stretches as a narrow strip 2,500 miles long and 40 to 200 miles wide along the west coast of South America. At the north end of the country, towards the Peruvian boundary and lying behind the hills of the sea coast, is a rainless desert of very considerable extent. About a century ago it was observed by travellers that the soil was impregnated with a white solid which, on examination, proved to be sodium nitrate, or, as it is usually called Chile nitre. In this region there has developed, somewhat slowly at first, a great industry devoted to the recovery of the sodium nitrate from the soil. When we recall that no rain ever falls in this district, and hence that there is no vegetation and that literally everything must be brought in from the sea coast by rail, the arid and uninviting nature of the country may be better realized. The soil is blasted out and loaded on railway cars, which transport it to the central factory, where it is boiled with water. There results a solution of sodium nitrate, which goes to the crystallizing tanks, and the muddy residue is thrown away. The solution, on cooling in open tanks, deposits the nitrate as snowy-white crystals. The product is shipped by rail to the sea and thence by ship to all the industrial countries of the world. When I add that in the year 1923 2,200,000 tons were exported from Chile, requi ing 110 ships making 4 trips per annum for this purpose, you will get some idea of magnitude of this industry.

During the war Great Britain, France and the United States were dependent entirely upon Chile nitre for the production of their explosives of all classes. How Germany and Austria managed we shall see later. With the commencement of the ruthless submarine campaign, the saltpeter ship from Chile became a specially attractive target, and for some time the dread spectre of a shortage in ammunition haunted the War Offices of Great Britain and France in consequence of the frequent losses of these precious vessels.

To-day sodium nitrate from Chile comes freely to Toronto and is sold either unmixed or as a constituent of practically all commercial fertilizers; 22,000 tons to came Canada this year. But it is a far cry to Chile, and the Government of that country, like all others, has close to its heart the problem of raising money. An export tax of $10.46 per ton is therefore levied on every ton exported,

and Canada has the satisfaction of helping to the extent of $230,000 to maintain the Government of Chile. It has been estimated that the Chilean deposits will be exhausted in about 100 years, which does not augur well for posterity.

And here we ask ourselves if there is no other source of nitric acid, and the answer is, "Yes, there are several."

Cavendish, while studying the composition of air, passed sparks from an electrical machine through air enclosed in a glass vessel and observed that nitric acid was formed. By continuing the passage of the sparks for a long time, and absorbing the nitric acid formed in lye, he was able to cause all the nitrogen to disappear, leaving only about $\frac{1}{128}$ part of the volume of the air which was taken originally. He was unable to explain the reason for the survival of this residue, and more than a century later Sir William Ramsay showed that the gas argon is present in the atmosphere in almost that precise proportion. While Cavendish described clearly this method of producing nitric acid from air, his observations passed almost unnoticed until in 1892 Sir William Crookes showed that the same result could be attained by the use of the electric arc. A little over 20 years ago two American chemists, working at Niagara Falls, made the first attempt to produce nitric acid by this method on a commercial scale, but they were not successful. Simultaneously two Norwegians, Birkeland and Eyde, at Christiania constructed a furnace in which they produced a gigantic arc through which air was blown. Their apparatus proved to be satisfactory and economical, and in the first decade of this century a great industry sprang up in Norway under the direction of these investigators.

It is well known that by a comparatively simple device, the electric arc playing between two terminals may be spread out into a circular or disc-like sheet, and in the Birkeland-Eyde furnace as now operated this is about 8 feet in diameter. A single furnace of this kind consumes about 5000 H.P., which would be sufficient to supply 5,300 of the old arc lamps such were used to light the streets of Toronto before the present system was adopted. Only about 3 or 4 per cent. of the electrical energy supplied is actually utilized, so that it is only possible to carry on this process where electric power is produced at a very low cost.

Through this gigantic sheet of flame, at a temperature of approximately 3000° C., air is blown, and a chemical combination manifests itself by the appearance of a brown colour in the air which emerges. Only 1 per cent. of the nitrogen at best is transformed, which emphasizes the comparative inefficiency of the process. The brownish-coloured air is conducted to immense towers built of granite where it is washed with water, the brown portion, known to chemists as nitric oxide, dissolving in water to form nitric acid. By boiling down or concentrating this dilute solution, ordinary strong nitric acid may be produced, but since this can only be transported and stored in glass vessels, not much of this acid is actually produced. By allowing the weak or dilute

acid to act upon limestone calcium nitrate results, and this, after the removal of the water, is a white substance readily shipped in bags. The final product of the arc process as operated in Norway is calcium nitrate, and in this substance Chile nitre has found its first serious competitor.

In this connection it is interesting to note that at the present time a factory using the arc process on a small scale is about to commence operations at Merritton, Ont., with an estimated output of 850 tons of nitric acid per annum. The process, as has already been mentioned, can only succeed where electric power is cheap, and this opens up some interesting possibilities in a country such as ours.

Having now seen how it is possible to make nitric acid from air by one process, let us turn to one of the other two by which the same goal may be reached.

In 1892 Willson discovered that if limestone and coal were heated together in an electric furnace, a substance was formed which, on the addition of water gave off acetylene. This was calcium carbide, consisting of the elements Ca and C, and the possibility of producing conveniently in any locality with simple equipment such an excellent illuminating gas as acetylene led to a very rapid growth in the manufacture of carbide. Without referring further to the manifold uses of acetylene, I must pass on at once to a further discovery. It was found early in this century that if nitrogen be passed over calcium carbide while hot, a new substance was formed which contained nitrogen in addition to calcium and carbon, and to which the name calcium cyanamide was given. This substance is itself a fertilizer though not so valuable as the nitrates, and it was with a view to manufacturing cyanamide fertilizer that the American Cyanamide Co. built a factory at Niagara Falls, Ont., in 1909 with a capacity of 60,000 tons per annum.

If calcium cyanamide be boiled with water under suitable conditions ammonia is produced and, as we shall see later, nitric acid can be prepared readily from the latter. During the Great War most of the cyanamide produced at Niagara Falls was shipped to New Jersey, where it was converted into ammonia, united with nitric acid to form ammonium nitrate and then used as the chief constituent in high explosive shells.

Just shortly before the War a German chemist, Haber, succeeded in bringing about the union of nitrogen and hydrogen by heating these gases to about 550° C. under heavy pressure. By means of catalyst, metallic iron with a little molybdenum, and using the high pressure of 3000 lb. per sq. in., he was able in 1905 to cause a mixture of nitrogen and hydrogen which was quite inert at ordinary temperature and pressure to unite to form ammonia to the extent of 17.5%, although in practice this figure is reduced to about 6%.

The process was taken up by the giant of the German Chemical Industry, the Badische Anilin and Soda Fabrik in 1910, and by

1914 a factory had been built at Oppau with a capacity of 25 tons of ammonia per day. When it is recalled that the working temperature is about 500° C., just barely below a dull red heat, and that the pressure is 3000 lb. per sq. in., the engineering problem of constructing the apparatus may be understood. Ordinary steel loses a great deal of its strength at such a temperature, and in addition was found to be attacked by the reacting gases, so that it was necessary to employ some of the new alloy steels which have only recently been discovered. The bombs in which the purified nitrogen and hydrogen are passed over the catalyst were, at Oppau, 39 feet high, 31 in. external diam., and 7 in. thick in the wall. The heating is done electrically within the bomb, and in this way the outer walls may be kept at a lower temperature. After passing over that catalyst the gases are washed with water, which dissolves the ammonia, and the residue is returned to the system. By 1918 Germany had two factories working the Haber process and producing 620 tons of ammonia per day from the nitrogen of the air and the hydrogen of water.

In 1918 a French engineer, Claude, who had already to his credit the invention of an excellent machine for liquefying air, announced that he had improved the Haber process by raising the working pressure to 15,000 lb. per sq. in. Claude has constructed and is operating a plant in France in which he employs this enormous pressure, the great advantage of which lies in the fact that the piping and catalyst bombs are of small size compared with those of the Haber process. Claude process plants are operating, or are being built, at fourpoints in France, and one factory is under construction in each of the following countries: Belgium, Spain, Switzerland, Italy and Japan.

An Italian engineer, Casale, has produced another type of synthetic ammonia apparatus, and two factories of his design are at work in Italy, another is under construction at Niagara Falls, N.Y. Italy has four factories for the synthetical production of ammonia, and the absence of coal in that country has involved the importation of all the ammonia required by the industries until the present time.

When mixed with the proper proportion of air or oxygen and passed over a catalyst, platinum or oxide of iron, heated to about 750° C., ammonia is burned or oxidi ed to form the same brown gas nitric oxide which comes from the arc furnaces. On dissolving this gas in water nitric acid is formed, and consequently it is a comparatively simple step to pass from ammonia to the acid which we are discussing.

However we may secure a supply of ammonia we are at the same time assuring ourselves of a corresponding quantity of nitric acid, and this serves to explain the great efforts put forth in Germany to make ammonia from nitrogen and hydrogen. During a war the supplies of Chile nitrate might be cut off, as actually happened, and being deprived of nitric acid Germany would have been unable to produce explosives. With the Haber process

carried on within her own boundaries any shortage of nitric acid was impossible, and the enormous development in the Haber factories during the war testified to their importance. One must, however, bear in mind the fact that cyanamide plants were at work in Germany for some time before the War, and consequently an independent supply of ammonia or nitric acid was available.

It is particularly worthy of note that in the arc process, and in the catalytic processes for making nitric acid, only nitrogen, oxygen and hydrogen are necessary, the two former obtainable from air and the latter from water, the only other requisite being electric energy.

Where coal is lacking and electric power is fairly abundant, as in Ontario, either of these processes are capable of being worked, and it strikes one as a curious contrast that the energy in a water fall, in some rocky and inhospitable district of our north land, may be utilized to produce the nitrate required to maintain the fertility of the broad plains of the West. It is not at all unlikely that we shall see before long such a plant erected, and it is quite conceivable that the production of sodium or ammonium nitrate may be one of the new industries to spring into life in those parts of Canada which have known hitherto only the Indian and the trapper.

STEAM ACCUMULATORS AS A FACTOR IN POWER COSTS

*By Alfred J. T. Taylor, A.S.M.E., Toronto

Invention of Dr. Johannes Ruths Permits Supply of Steam at Any Time and Quantity, Canadian Combustion Expert Claims, in Emphasizing the Quality it Effects in the Products of a Plant

Widely fluctuating loads in a boiler plant do more to adversely affect economy than possibly any single influence. In Canada very few exact investigations have been made of the influence that the variations in the rate of production and consumption of steam or power exercise on the working methods, and the overall efficiency obtained in industrial plants. On the contrary, the heat balances of such plants have invariably been set down, as if the source of energy to be used on the one hand, and the consumers of energy on the other, were delivering and absorbing energy at a constant rate without any variations. In practice these variations have been accepted as unavoidable, and attempts have been made to counteract their effects by forcing the boilers, which causes considerable losses, owing to the fact that the supply of heat on the one hand, and the consumption of steam or power on the other, are by no means equivalent in quantity nor coincident in time.

Storing Steam in Water

There is, however, a principle of storing steam in water under increasing pressure and discharging it under falling pressure that provides an excellent means for avoiding the evil effects of fluctuating demands for steam, and virtually places the consumers of energy or heat independent of the rate of supply from the boiler.

A steam accumulator, invented by Dr. Johannes Ruths, of Sweden, and in use in Scandinavia and other countries on the continent of Europe, more than seventy such devices being found in the pulp and paper industry alone, merits the attention of the English-speaking world.

The accumulation of steam in water and its subsequent evaporation is a well-known principle, and has for a long time past been used by practical engineers; in this connection reference may be made, for instance, to the Rateau accumulators and the feed water accumulators of Druitt Halpin and others. The direct storage of steam without water has also been effected in practice, both in containers of constant volume and in containers of variable volume.

Stores up Exhaust

In all cases just mentioned, however, with the exception of feed-water storage systems, the definite aim in view is that of

*From a paper before Local branch of the A.S.M.E.

accumulating the exhaust steam of hoisting engines, or rolling-mill engines, etc., where the work proceeds intermittently, so as to make it possible to pass the exhaust steam from these engines into continuously working low pressure turbines, even during the intervals when the main engines are at rest.

Every steam boiler of very large water content could in principle be arranged as an accumulator, but, in order that the boiler may act as an equalizer, it must be constructed for a pressure above the normal working pressure, so that variations between the maximum and the normal working pressure may be obtained.

The fact that no such increased pressure has been provided for, but that, on the contrary, boilers are usually constructed for a pressure only so much higher than the steam pressure needed as corresponds to the pressure drop in the pipe lines, proves that the principle referred to has never been carried through completely in practice.

Keeping Pressure Constant

Instead of aiming at accumulation by permitting variations of pressure, efforts were and are still, on the contrary, directed towards keeping the pressure as constant as possible. It is usually considered as evidence of good working if the boiler pressure diagrams approximate as closely as possible to straight lines.

As, with constant boiler pressure, no accumulator action is possible, it follows that the quantity of heat conveyed from the fire to the heating surface per unit of time must likewise exactly correspond to the amount of steam that the boiler is required to supply. It is, therefore, evident that the variations in the steam demand must cause corresponding variations in the fuel supply to the boiler.

The only correct solution of the problem of rational steam utilization is to employ the steam boiler exclusively as the steam generating agent, working at a constant load, and to dispense entirely with the use of the boiler as an accumulator.

Needs Little Water Space

Accordingly, the steam generator may be built with very small water space, or even with none at all—in the latest constructions the steam generator is, practically speaking, simply a coiled pipe—and should be worked at an absolutely constant high pressure. Instead of every common type of boiler, at present having its own water tank, which, consequently, must be built to stand the full boiler pressure, the water spaces of all the individual boilers should be, so to say, united into one tank, entirely separated from the boilers and well insulated against loss of heat.

In such tanks, usually built for pressures lower than those of the boilers, a much larger variation of pressure is attainable than in the boilers. Furthermore, these tanks can be built of any size whatever, irrespective of the type of boilers used or of the size of their heating surface.

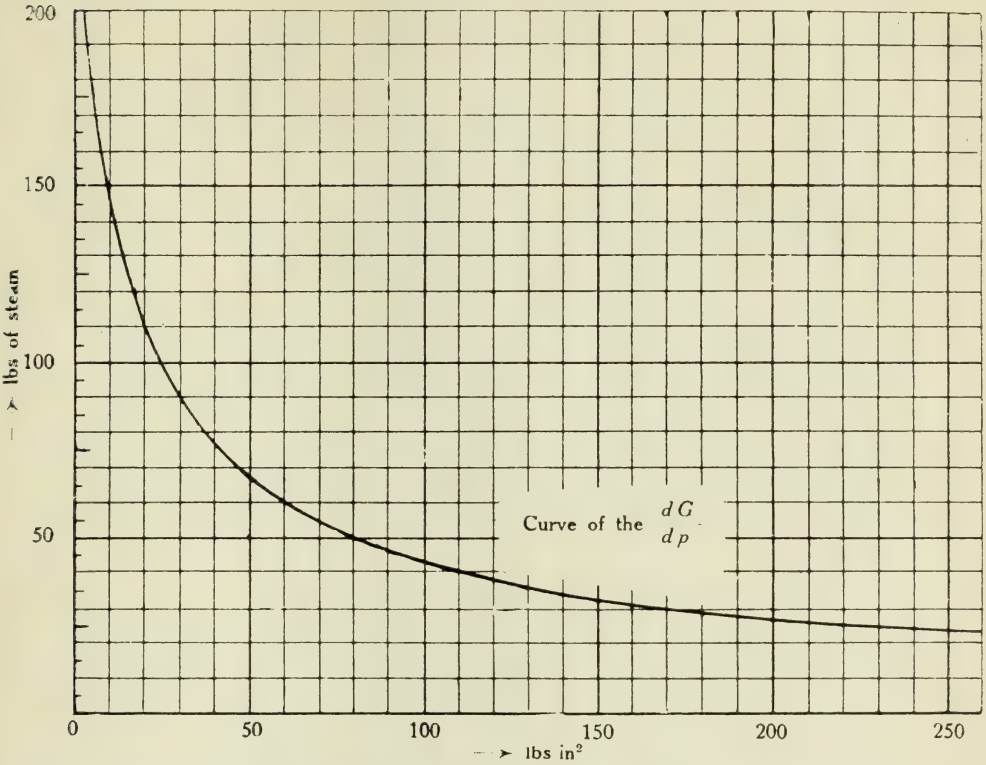


Fig. 1.—The amount of steam G, produced by 100 ft.³ of water through a drop of pressure 10 lbs./ins.² for various steam pressure p.

In order to illustrate the importance and scope of this idea, an analogy from a different invention may be cited. The writer refers to the success obtained by Ilgner in the equalization of load and supply in power plants by separating the energy storing flywheel from the main engine and driving the former by a separate engine.

In this way, Ilgner succeeded in overcoming great variations of short duration in the rate of power consumption of certain types of machinery, such as rolling mills, hoisting plants in mines, etc., which variations it had not previously been possible to overcome by the use of flywheels arranged in the usual way.

Eliminates Variations

This same principle has been applied by Dr. Ruths to the production and use of steam, and he has thereby succeeded in eliminating all variations in the rate of supply as well as in the consumption of steam.

In the same way as Ilgner separated the flywheel from the main engine, Dr. Ruths has separated the water space from the boiler, and has a separate container, in which the steam is accumu-

lated or stored under pressure. By this means the mass of accumulating water working in the steam system representing a large "flywheel effect" can be increased to any desired extent.

As it is not necessary that the accumulator should be built to stand the high pressure of the boilers, full use can be made of the property of hot water to accumulate much more steam at low than high pressure for a given pressure drop.

The importance of this may be clearly seen from Fig. 1, in which the amount of steam produced per unit of volume (or 100 cu. ft.) of boiling water for a certain pressure drop (or 10 lbs. per sq. in.) is shown for various steam pressures.

It must also be observed that the accumulator, when separated from the boiler, can be so arranged that a very much greater pressure-range may be permitted in it than is possible in a boiler.

Dr. Ruths, when he approached the subject of steam accumulation, did not confine himself merely to the saving of exhaust steam, as Rateau and other engineers had done, but set himself the problem of overhauling the entire heat and power economy of industry, from the point of view of the accumulation of steam in water.

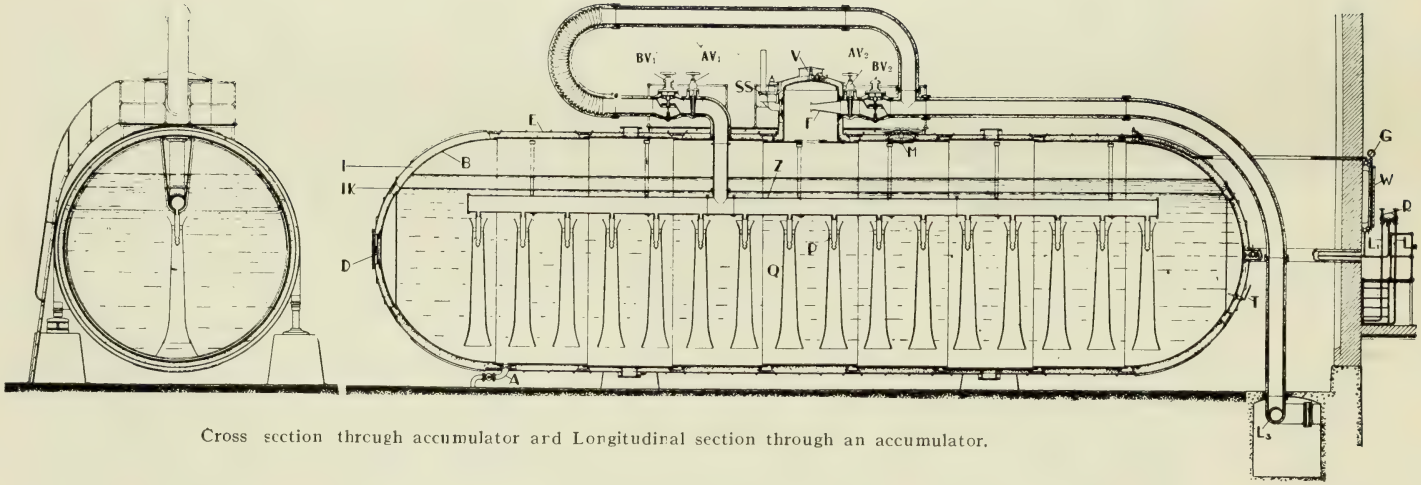
Little Study of Variation

A survey of the literature on this subject shows that the conditions affecting this general question have not been fully recognized, so that there was not only the task of solving the problem to be done, but first of all to work out a clear and definite formulation of it. That this was necessary is conclusively proved by the fact that the number of cases is very small in which the variation of energy, especially heat energy, in the various branches of industry have been systematically studied.

In research work extending over many years in the great variety of industries, the author has executed a large number of measurements of the rate of steam consumption. Out of the results of that work the problem of general steam accumulation was formulated and its subsequent solution evolved.

Ruths' accumulators are built in the form of cylindrical steel tanks with hemispherical ends. They are filled with water up to 90-95 per cent. of their capacity. Fig. 2 shows a sectional view of an accumulator. B is the vessel constructed of riveted steel plates. I is a covering of non-conducting material, usually consisting of up to four inches of infusorial earth (kieselguhr) or infusorial earth mixed with cork, or of a magnesia composition. J-K are insulation blocks covering the riveted seams of the shell. They are made movable, so as to enable the inspection of the seams to be readily carried out. The lagging is protected by a sheet iron cover, E.

The accumulators are equipped with the fittings usual in boiler practice, and further with arrangements for the charging and discharging of the steam, two non-return valves BV_1 and BV_2. BV_1



Cross section through accumulator and Longitudinal section through an accumulator.

admits charging steam to the internal steam distribution pipe Z, and the charging nozzles P, which are equipped with the circulation pipes Q to insure a uniform heating of the water. Through valve BV_2 the discharge of steam takes place. Fig. 3 shows a typical installation.

Heat Losses Low

The heat losses of the accumulators are considerably less than is generally imagined, as a matter of fact so small that they are of no practical consequence. Result of insulation tests made on accumulators in practice show that with the thickness generally adopted, the heat losses only correspond to from 0.1 to 0.5 per cent. of the coal consumption of the boilers, and are, therefore, of little importance.

That being so, the accumulators are usually erected in the open air, and often at some distance from the boiler-house, in factory yards, etc.

From this description it is evident that such an accumulator, although it can be charged with superheated as well as with saturated steam, can only deliver saturated steam. In certain cases, however, it is desirable to have an accumulator that can also deliver superheated steam. This is of great value, especially in plants where the accumulator has to feed such consumers as steam engines, steam turbines, steam hammers, etc., which utilize the energy of steam for the production of motive power.

The possibility of feeding such consumers with superheated steam means a considerably lower steam consumption and hence a reduction in the accumulator capacity needed.

Add Second Container

This problem has been solved by adding to the steam accumulator a second container, so designed that it works on the same principle as the Siemens regenerative heater used in connection with metallurgical furnaces for pre-heating the gas and the air of combustion.

The accumulator for superheated steam thus consists of two separate containers, one for storing the superheat, and one for the storage of the latent heat of the steam.

Special Uses for Accumulator

Apart from the general value which a steam accumulator has in the numerous plants where there are variations in the demand of steam for heating or for power purposes, or where there are variations in the supply of heat (surplus gas, waste heat, etc.) an accumulator can be used in connection with power transmission systems, *e.g.*, those utilizing water power.

The combination of a steam accumulator with one or more steam turbines is a useful means of maintaining a local stand-by working with small no-load costs and other working expenses.

Even in cases of sudden interruptions in the supply of current from long-distance power transmission systems the local load can, if required, be taken over without any delay by a steam turbo-generator, fed by the accumulator, without the necessity of keeping the boilers permanently under steam. The steam accumulator will in such cases take the place of lead batteries.

Further, in industries such as iron and steel works, where a co-equalization has to be maintained between the variation in the supply of energy (surplus gas from blast furnaces and coke ovens, waste heat from furnaces and engines) and the fluctuations in the consumption of energy for power purposes, the steam accumulator is of more commercial and technical value than expensive Ilgner type plants and the storing of low-grade blast furnace gas in gasometers.

It is interesting to note in the latter connection that one pound of steam which, when stored in a steam accumulator, occupies .02 of a cubic foot, corresponds in thermal value to about 16 cubic feet of blast furnace gas.

Results Obtained

The working of the manufacturing plant and power plant is rendered independent of the working of the boiler plant.

In a factory or power station equipped with an accumulator, steam can be supplied at any time at an unlimited rate, should it be required in manufacturing operations, or through peak loads in the power distribution system.

For example, a heating process normally consuming steam at the rate shown by Curve I in Fig. 4 (which rate is dependent on the steam supply from the boilers) can be intensified by accumulated steam to the high rate shown by Curve 2, whereby the time (T-t) is saved.

By having a steam supply which is unrestricted, although the boiler load may be constant, costs for installing or extending manufacturing apparatus or boiler plant are materially reduced by the more intensified use of the existing installation.

Uniform Product

Lack of steam often occurs in factories just when an increased supply of steam is badly needed for carrying through a manufacturing process. The process is then delayed or the quality of the product lowered.

It must be borne in mind that as a rule, of two operations proceeding simultaneously, the cruder process, such as "heating-up," etc., will generally use steam to the detriment of the more refined operations, like drying or chemical processes.

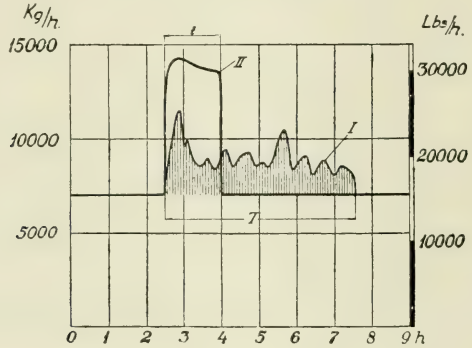
By impediments of this kind the conduct of the manufacture, from the point of view of obtaining high quality, is rendered more difficult, and, as a matter of fact, irregularities of this nature in the steam supply to the individual apparatus are frequently the cause of the production of so-called "second-class qualities."

By the adoption of an accumulator, different processes can be conducted independently of one another, and with something like laboratory exactitude.

Consumption of Fuel

By the action of a steam accumulator the peak-loads are taken off the boilers and their pressures kept constant. Fires can be closely adjusted to give the most favourable combustion of the fuel, economy resulting, together with more even working and less wear and tear.

An accumulator furnishes the possibility of keeping the boiler pressure constant, and just below the blow-off pressure of the safety valves, which fact has a favourable influence on the output of back-pressure turbines or engines.



Reduction in time required to get up steam in a factory after installation of an accumulator. Curve I—Diagram before installation of an accumulator; Curve II—with accumulator.

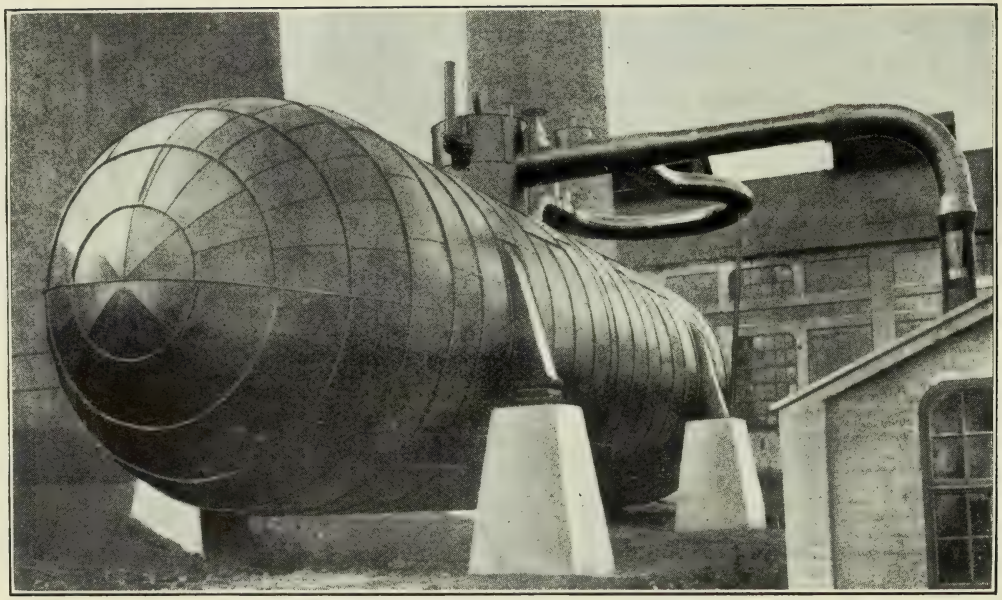
Moreover, the output of the high pressure stage of an extraction turbine or of a simple back-pressure turbine is materially increased by the equalizing influence of the accumulator, as with the constant steam flow from the boilers through the turbine, very small losses occur in potential energy of the steam by throttling.

If a back-pressure extraction-power system does not comprise an accumulator, and the fluctuating steam flow to the consumers is as usual led through the back-pressure turbine or the high-pressure stage of the extraction turbine, it must be run at a variable load and consequently great throttling losses result.

Gain in Turbine Output

The action of the accumulator effects a further gain in the output of such a turbine from the fact that, despite all the variations in the steam demand, practically all the steam produced by the boilers is conveyed through the turbine.

It often occurs in such plants, when not provided with an



Accumulator in the Kvarnsveden Paper Mills of the Stora Kopperbergs Bergslags A.B., at Kvarnsveden near Borlänge (Sweden). Capacity 6350 ft., length 51.5 ft., diameter 13.1 ft., accumulating capacity 17600 lbs. of steam.

accumulator, that large quantities of heating-steam have to be by-passed direct from the boilers without power generation, as it is seldom of advantage economically to make the turbine of such a size that it can pass the maximum demands of heating-steam which occur, for instance, only when digesters are started, dyeing vats are heated up, etc.

Even in the case of a steam power plant, from which no steam is abstracted or exhausted for heating purposes, as, for instance, in an ordinary power station, there is no loss of power by the insertion of an accumulator, eventually arranged for super-heated steam, between two turbine stages.

Boiler Pressure Constant

As the boiler pressure as well as the super-heat are automatically kept at maximum values by the accumulator, and as, further, the efficiency of the high-pressure stage is practically constant, though the accumulator pressure varies, and as also the low-pressure stage —especially if it is equipped with automatic nozzle control—utilizes the steam from the accumulator without extra losses, the total heat drop available is not less with an accumulator introduced between two turbine stages than it would be without it.

At most, the heat drop is reduced by an amount corresponding to the extra back-pressure caused by the water-head above the nozzles in the accumulator. This head, however, is small, so that the loss entailed is of no practical importance.

This subject is far too wide in theory and application to be dealt with in one article in Power House. There is, in the writer's opinion, no single advance in steam generation during the past ten years that means so much to the heat-using industries as the accumulator.

PROTECTIVE LEGISLATION

*By Professor H. E. T. Haultain

Professor Haultain said in part: I feel very genuinely that it is an honour to address the Engineering Society and it is also a very definite pleasure. I seize this opportunity to again congratulate you as a society. Sir Robert Falconer has said on more than one occasion that the Engineering Society represents what is best in student activities and Sir Robert doesn't say that sort of thing without meaning it. It is not alone for what you do that you are recognized, but it is also for what you stand. In time of difficulty we know where the Engineering Society will be; on the side of what is right and decent and reasonable. You are to be congratulated on your leaders, on your ability to pick the right men for leaders and what, perhaps, is even more important, to follow them when you have picked them. It is a splendid manifestation of the old tribal spirit. The Engineering Society is one of the fine things that School owes to John Galbraith. He organized the Society about 39 years ago, and for the first three years was its President and then handed that office to the students. I have never been prouder of anything than that I was the first student President of this Society 36 years ago, and now I come to you as President of the Association of Professional Engineers of Ontario, and I am glad indeed that my first appearance in this office should be before you.

Now in regard to this legislation for Engineers. It is an old subject which has been taken up at intervals for many years. Twenty-five years ago the Canadian Society of Civil Engineers made an effort to obtain the necessary Dominion legislation and failed. Quebec and Manitoba succeeded in obtaining special legislation, but it was of very little effect. Six years ago the Engineering Institute of Canada called a conference of representatives from all parts of the Dominion with instructions to sit in conference in Montreal until they had unanimously approved of a draft Bill that might be presented in each province of the Dominion. They held twenty-one sessions and after much compromise drew up a Bill which is the foundation of present day legislation in seven of the provinces. This legislation has been termed Protective Legislation, and what do we mean by that term? In the first place it must mean protection for the public, the public must be guarded from inefficient work. Everybody sees that in the case of the Doctors, people must not be allowed to place their lives in the hands of a man who is not properly qualified for the work. How often are the public called upon to entrust their lives to the Engineers? The life of the ordinary man depends upon the Engineer far oftener than on the Doctor. Think it over. In the second place protective legislation should mean

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protection from unfair competition for the Engineers themselves. There are many who consider the latter a more important phase. Personally, the protection of the public is, to my mind, the much more important phase. By far the larger majority of Engineers need no protective legislation. They do need, however, the status and recognition by the public which such legislation would help to promote.

There are, at least, four divisions of Engineering organization. First, the student organization, such as you have here. Second, that organization which stands as a guardian of the profession, concerns itself with professional ethics and stands for all that is best in the profession. Of this class we have the Institution of Civil Engineers in England, the father of them all, and the Engineering Institute of Canada. Third, there is the organization concerned more with the exchange and dissemination of technical information and ideas, not concerning itself with professional ethics, concerning itself more with the industry than with the profession, for example, The Canadian Institute of Mining and Metallurgy. Fourth, the recently formed Association of Professional Engineers in each province, whose main function is the obtaining of suitable legislative enactments. A few years ago most of us thought that such legislation was impossible, mainly because you cannot define Engineering. You cannot say where Engineering begins and the work of the capable artisan ends, but that notable conference in Montreal six years ago showed us the way. Ontario took that draft Bill and proceeded to get together representatives of the Civils and Mechanicals and Electricals, Miners, Chemicals and Architects in an effort to get unanimity of opinions. It took two years of patient work, during which the Architects dropped out of the scheme. Finally a Bill was tentatively approved of, but before it left the committee stage it was assailed from many angles, even by some of the Engineers themselves. It is due to the dogged perseverance of a small group, of whom, let me say plainly I was not one, though I was on the side lines, that a much altered Bill was passed. It was apparently so weakened that most Engineers said it was worse than useless. The only thing that it protected was the use of the term "Professional Engineer," but this has proved to be of great educational value, not only to the public, but to the Engineers themselves. It also gives us the power to discipline our members and to compel the giving of evidence under oath. Some provinces obtained legislation which nominally made ours a closed profession like Medicine, but enforcing the act has been difficult if not impossible in some districts. We have a good illustration of that in the O.T.A. Personally, I am glad we started off as we did. It is now up to us to get more legislation, and before we can get this we must carry on an intensive campaign of education of ourselves and of the public and of the politician, and this educational work will do us as much good as, possibly more than, will the ultimate legislation. In Quebec, however, they revised their old act three or

four years ago and the new form is very stringent and well-established and they have succeeded in making it stick. Recently they caused a man to be fined $300 and costs for a breach of the Act and as a result of that one case they have settled 44 cases out of Court.

In all this education of the public there is something else, our old friend the tribal spirit. If we can get people to realize that here is a group of men who stand for what is decent, and will not stand for what is not decent, it will mean more to the profession than any legislation we could get through. What the profession needs more than anything else is to create and maintain the same tribal spirit which the Engineering Society has here. Lately a good many of us have been thinking that the transition the graduate goes through is too sudden. You are turned out to shift for yourselves in a world which has not much interest in you, and by the time you find your feet the old spirit of tribal loyalty has all but disappeared. What are you fellows going to do to help you take your tribal spirit out into the field? Look around the whole world to-day and you will find that there is no movement without an organization and propaganda. Every branch of Engineering has its organization and there are a thousand and one other organizations in Toronto alone. Here you men are supported on all sides by an organization. You have the Faculty and you have the Engineering Society, both of which you lose suddenly when you graduate. What does the E.I.C. do for you? What does the C.I.M.M. do for you? You may join as student members but how much does that really mean? It would appear as if the young graduates were without an organization and without propaganda. Think it over.

PRESENTATION TO THE SOCIETY BY J. ALLAN ROSS OF THE COMPLETE REPORTS OF THE GREGORY COMMISSION IN MEMORY OF J. WALTER FRANCIS

On March the 4th a complete set of all the reports of the recent Hydro Enquiry Commission, generally known as the Gregory Commission, was presented to the Engineering Society by Mr. J. Allan Ross, in memory of Walter Francis. Mr. Ross had been a member of this Commission and had preserved his files complete in every respect covering all the reports made to the Commission and by the Commission to the Government. There are not more than six such complete sets in existence. It is without question the most extensive and the most complete Report on any Engineering project that has ever been made, and is a model of the very highest order of what a Report should be.

Mr. Francis was Consulting Engineer to the Commission and under his direction, aided by a staff of more than 60, data concerning all the Engineering, economic and historical details of the entire work of the Hydro-Electric Commission in Ontario was compiled. The gathering of this material required some 23 months and the total cost involved in the work of the Enquiry Commission and the preparation of the Report was in the neighbourhood of half a million dollars, and the works reported on involved an expenditure of two hundred and fifty million dollars. This work was finally completed only a short time before the death of Mr. Francis, and there is no doubt that the tremendous effort that he expended in perfecting this Report in every detail hastened his death.

The Report occupies about 8 feet of shelf. It is proposed that it shall be housed in the University Library under the control of the Librarian in a special case with a suitably engraved plate.

A number of members of the Society had gathered to receive the presentation, and were addressed by Mr. T. H. Hogg, Hydraulic Engineer to the Hydro-Electric and President of the Engineering Alumni Association. Mr. Hogg said, in part:

"It was the duty of Mr. Francis to collect all the engineering and financial data in connection with this investigation. The Power Commission was more or less on trial. He handled it most diplomatically; of course he was a School man, and many of the officials of the Commission were School men. That may have accounted for his intense sympathy and the courteous manner in which he approached various members of the Commission. You will understand that with one side on the defence and the other looking for the truth you are liable to get into difficulties. Some of the members were not very sympathetic. It is due principally to Mr. Francis and to two members of the Investigating Com-

mission, Mr. Ross, an old graduate, and Mr. J. Allan Ross, who has made this presentation to you, that this report could not be any fairer than it is.

". . . It was Mr. Francis' and Mr. Ross' idea that this report should be published; however, when the new government came in they found finances in such a terrific state that they could not find the funds. It would have entailed a very large amount of money. There could not have been a more courteous act than that of Mr. Ross in handing this report to the Engineering Society for their own records, and perhaps the most courteous feature of the presentation is the mention of the name of Walter J. Francis.

"Mr. Francis, as you know, was a very young man when he died; fifty or fifty-two. He was just at the height of his powers. When we are close to a man we sometimes don't appreciate him; I think we didn't appreciate Francis properly. To my mind he was one of the greatest men who has graduated from the Faculty of Applied Science and Engineering. His greatness came perhaps not so much from his ability as a constructing engineer . . . but is really in the human aspect of the man. He was the most human man that I ever ran up against. Nothing was too much trouble for him. While this report was being compiled he was doing many other things. He was President of the Alumni of the Faculty of Applied Science, President of the Engineering Institute of Canada, Vice-President of the Corporation of Professional Engineers of Quebec; a member of the American Society of Civil Engineers and of the Institute of Civil Engineers of Great Britain; a charter member of the Institute of Consulting Engineers; a life member of the Engineering Society of the University; a member of the Montreal Board of Trade, of the Rotary Club, the University Club and the National Club. He was interested in the Boy Scout and Wolf Cub movements, being President of the Montreal Boy Scouts. He was Secretary of the Shriners Hospital for Crippled Children of Montreal; he was a great Mason. He gave to every organization that he went into the best that was in him. That is the reason I would class him as a great engineer and graduate of this faculty.

"Many of our graduates are very selfish. All we think of is the accomplishment of something which will stand as a credit to ourselves from a professional viewpoint. What we should try to do is to secure a little more of comfort to the ordinary individual, and I think that Francis has done more of that than any of us can ever hope to do. That is why the name of Walter Francis will go down in history."

The following is a letter received from Mr. J. Allan Ross.

Gentlemen:

I regret very much that I will not be able to accept your kind invitation for Wednesday afternoon.

May I take this opportunity of writing a few words about our mutual friend, the late Walter J. Francis?

It has been well said that men make the University. Bricks form merely the outward signs—that the history of a University is the history of the achievements of its men. Walter J. Francis, whose intense life was brought to a close last year at the height of his powers, was one of those outstanding men who have helped to place the University of Toronto among the foremost universities on this continent.

Mr. Francis was a distinguished engineer. His life of intense work very clearly determined his high calibre.

When the Hydro-Electric Inquiry Commission was appointed by the then Provincial Government to investigate all phases of Hydro development in Ontario, the engineer member of this Commission, Dr. R. A. Ross, was insistent that Walter Francis was the best equipped man in Canada to undertake the engineering section of that Inquiry.

The result of two years of intensive labour, covering a most thorough investigation of all engineering features of the Hydro enterprise, unquestionably hastened Mr. Francis' death, but the report on Hydro, which he had just completed, now stands forth in the opinion of foremost electrical engineers as the finest report of its kind ever produced anywhere. Walter Francis, in his achievements, touched life at fundamental points. He was, as you all know, much more than an engineer. He believed in the humanities, as was evidenced by his Presidency of the Montreal Rotary Club, and countless public services. He was a man engaged in big, elemental things. His is the type of School of Science graduate who constitutes the very background of the Institution.

As Arthur D. Little says, writing in the *Atlantic Monthly*, about the membership of the National Academy of Sciences: "They have recast civilization through their study and application of the great fundamental facts of nature and the laws of her operation."

If we stop a moment to consider we realize that engineers are recasting civilization every day. Francis was such an engineer. Gaby, Acres, Hogg, and others are also of this type.

It is a privilege to present to the University of Toronto my Hydro-Electric Inquiry Commission library, which, in the main, is a complete endorsation of our great Provincial Hydro development, and, as a report, is worthy of careful study by every student who is interested in the engineering, financial, and governmental relations of the Hydro development in Ontario.

Yours sincerely,

ALLAN ROSS.

SUDDEN SHORT CIRCUIT PHENOMENA IN A.C. SYSTEMS

By Arthur H. Frampton

Prize Essay in Competition of the Toronto Section of A.I.E.E.

1. Introduction

The tremendous growth of the modern generation and transmission system has rendered of vital importance the adequate protection of the system against damage due to short circuits, etc. Continuous and reliable service is contingent upon the proper selective action of relays, and the subsequent behaviour of the circuit-breakers operated by such relays.

In order to intelligently attack the problem of providing this protection, an accurate knowledge must first be gained as to the possible magnitude and character of the transient disturbance, to be dealt with under the condition of short circuit. It is the purpose of this paper to, first, outline the factors which may effect the magnitude and character of this transient disturbance second, describe a few of the more general schemes used to study the disturbance which may obtain on any particular installation.

2. Short Circuit Phenomena

(A) *Factors Affecting Short Circuit.*

It may be stated that the magnitude and character of the transient disturbance, which will occur when short circuit occurs on a system, will be affected by the following factors:

1. The total K.v.a., reactance, and transient characteristics of the synchronous machinery connected to the system.
2. The K.v.a., arrangement, resistance, reactance, and capacitance of all reactors and transformers through which power can be supplied to the point of short circuit.
3. Number, resistance, reactance, capacitance, and arrangement of all circuits over which power can be supplied to the point of short circuit.
4. Contact resistance at the short circuit.
5. The nature of the short circuit, whether single phase or three phase.
6. The K.v.a. and power factor of the load being carried at the time of the short circuit.
7. The point of the pressure wave at which short circuit was established.
8. The use of automatic voltage regulators.

It is the general practice to assume a value for certain of these factors, such that the conditions obtaining at s.c. will be the worst possible, as these must be provided for in any event. The contact resistance is therefore assumed as zero; the s.c. is taken as involving all three phases; the load being carried is assumed as 100% at a power factor of .8, and the s.c. as being established at that point

on the pressure wave which gives maximum possible instantaneous current. The effect of voltage regulators is usually neglected.

With the value of these factors assumed we need only consider the effect, then, of the synchronous machinery, the transformers and reactors, and the circuits over which power may be supplied. It is very common practice to simplify the problem still further, by neglecting the effect of resistance and capacitance, and considering only the effect of the reactance of the apparatus involved.

(B) *Short Circuit of Synchronous Machines*

While other factors may influence the *magnitude* of the s.c. current in any system the *character of the transient wave* is governed almost exclusively by the synchronous machinery connected to the system. This machinery may be in use as alternators supplying the line load, as synchronous condensers floating idly on the line, or as synchronous motors supplying mechanical power, but the characteristic of delivering large values of current when suddenly short circuited is common to all. This very large value of current, occurring immediately at s.c., is known to decrease to a very much smaller value in a short time after s.c. occurs. The general shape of this transient is given in Fig. 1. In this particular case, the s.c. occurred as the current wave was approaching zero, from the negative alternation. The *initial* rush of current is represented by CA. This initial value is limited by what is known as the "armature reactance," or the "inherent reactance," of the machine.

FIG. 1.

GENERATOR CHARACTERISTICS.

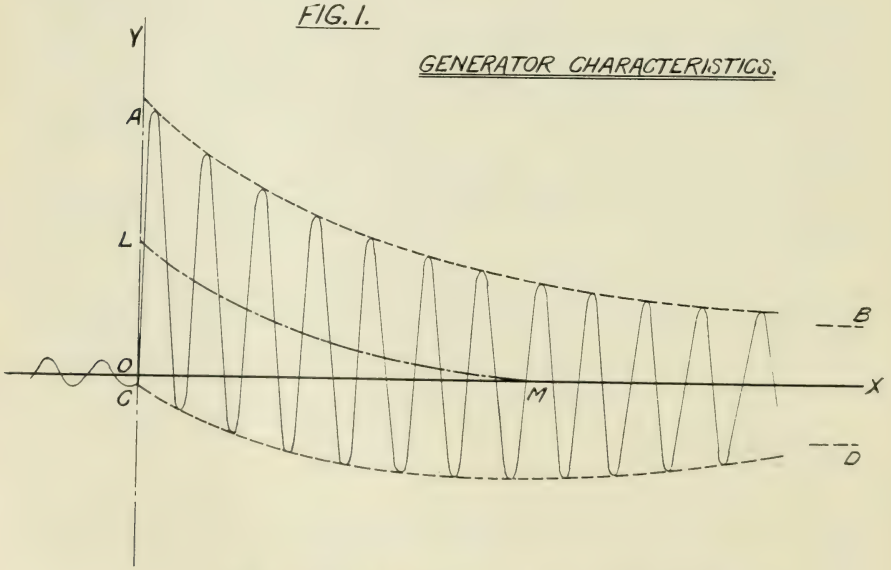


Illustration of behaviour of generator current when short-circuited from full load at 0·8 power factor

This reactance, while spoken of broadly as "armature reactance," should include the combined self-inductance of both the armature and field circuits, as is shown by Messrs. R. E. Doherty and O. E. Shirley in their paper published in the 1918 edition of the Transactions of the Institute.

The transient current then decreases along the familiar logarithmic curve, till it reaches a sustained value represented by the limits BD. This value is reached in approximately 2 seconds, though the time is placed by some writers as low as 0.8 seconds, and by some as high as 3 seconds. The magnitude of the sustained current is limited by what is known as the "synchronous reactance" of the alternator, and the sustained value is reached when the field flux and the opposing flux of armature reaction reach a stage of equilibrium.

This value of synchronous reactance (or impedance, if resistance is not neglected) is readily obtained by the familiar "s.c. impedance" test. The alternator is short circuited and the field strength increased until full load current flows in the armature. The armature circuit is then opened, and the open circuit voltage is measured. Dividing this open circuit voltage by the rated load current gives the synchronous impedance in ohms. For ease in calculation, this voltage is often expressed as a percentage of the rated voltage, and the value so obtained is termed the "percent. impedance" of the machine. Given this value for any machine, the s.c. current is obtained, as a multiple of rated current, by the quotient 100 divided by the per cent. impedance.

Because of the fact that the true inherent, or "transient," reactance of the machine is not readily measurable, the value of the initial current is usually determined by subjecting the particular machine to an actual s.c. test, and measuring the current by means of an oscillograph. Several methods have been advanced for calculating this reactance, or for determining the value of the initial current, from the design data of the machine, but each method adopts some assumed value for the effect of the field self-inductance and is therefore open to criticism. However, certain of these methods, particularly that advanced by Messrs. Doherty and Shirley in the A.I.E.E. Transactions, 1918, obtain very close checks between the calculated values and those obtained by actual test. The value of the transient reactance can be expressed in the form of a percentage in exactly the same form as the synchronous impedance.

The current wave obtaining at s.c. may, or may not, be symmetrical about the zero line. If s.c. takes place when the voltage is at a crest value the current wave will be symmetrical, but if the voltage is at zero, the initial rush will be totally offset to one side or other of the zero line. The degree of offset may also vary anywhere between these limits depending on the point at which s.c. occurs, but, in any case, the alternating wave will be of the same amplitude.

If the wave is offset it means that a d.c. component is present.

in addition to the a.c. wave. This d.c. component, represented by L.M. in Fig. 1, disappears in approximately 0.15 to 0.25 seconds, and the wave becomes symmetrical. It is this fully offset value of the initial current which must be allowed for in designing the synchronous machine, and its value is usually taken at 1.8 times the symmetrical value.

(C) *Transformers*

We have seen that it is the characteristic of synchronous machines to deliver large values of current upon s.c. If a transformer is included between the machine and the point of s.c., the transformer acts merely as a series impedance, limiting the magnitude of the transient current.

The value of this impedance (or reactance, if the resistance is again neglected) is determined by the well-known s.c. impedance test. The secondary is short circuited, and the voltage is raised upon the primary until full load current flows. The "equivalent impedance" of the whole transformer is then, this impressed voltage, divided by the current flowing. As before, the percentage this voltage is of the rated voltage is a very convenient expression for use in calculations of the total impedance, or reactance, of a system, and this "percent. impedance" is the expression usually given.

Suppose a transformer is rated as having 5% impedance. This means that 5% rated voltage will cause full load current under s.c., or, that rated voltage will cause 100 divided by 5, or 20 times full load current.

(D) *Protective Reactances*

In practically all modern installations the use of protective reactances, or current limiting reactors, is standard practice. These reactances are included in the network at strategic points, usually in generator leads, between bus sections, or in power feeders, in order to limit the current at s.c. by providing additional series impedance.

This reactance, while it may be expressed in ohms, is also more conveniently expressed as a percentage, in precisely the same manner as above. It is usually expressed as a percentage of the rated voltage drop that is caused by a certain current flowing through it. This current is often taken as that which would flow when a 10,000 K.v.a. load is being drawn through the reactor; but if the reactor is connected in the leads of a generator, it is more often full load current on that generator.

(E) *Cables and Transmission Lines*

It is readily seen that the only possible effect of any length of cable or transmission line included between the power supply and the point of s.c. is to limit the flow of current to the fault.

In considering the effect of the cable, due regard must be paid to the cable resistance, as well as its reactance. The reactance,

which in this case includes capacity reactance, as well as inductive reactance, is more nearly comparable to the resistance in the cable and cannot theeefore be neglected. However, cables are seldom of sufficient length to offer any serious impedance to the current on s.c. and will not be further considered here.

The effect of the transmission line, unless of extreme length or of iron wire, can again be said to be a function of its reactance only. This reactance can be readily calculated in ohms (per mile of line, say) by several well-known methods, when the size of conductor, spacing and frequency of the line is known. To comply with the previous cases, this reactance is expressed as a percentage, by the percentage of rated volts drop that it causes, when some specific load is being carried. The usual practice is to specify 10,000 k.v.a. as the load, even though line has only a fraction of this capacity.

Having now considered the effect of each of the component parts of a generation and transmission system upon the transient s.c. phenomena, let us now consider a few of the more general means of determining the magnitude of that disturbance, selecting a number of typical installations to illustrate the principles involved.

3. Short Circuits on Power Systems

(A) *Calculation of Short Circuit Currents*

With power systems of the capacity and intricacy of the present day, it is extremely impracticable to actually apply short circuits to the system, in order to study the nature of the resultant transient phenomena. However, such data is, in the majority of cases, obtainable by methods of calculation, to within a very fair degree of accuracy.

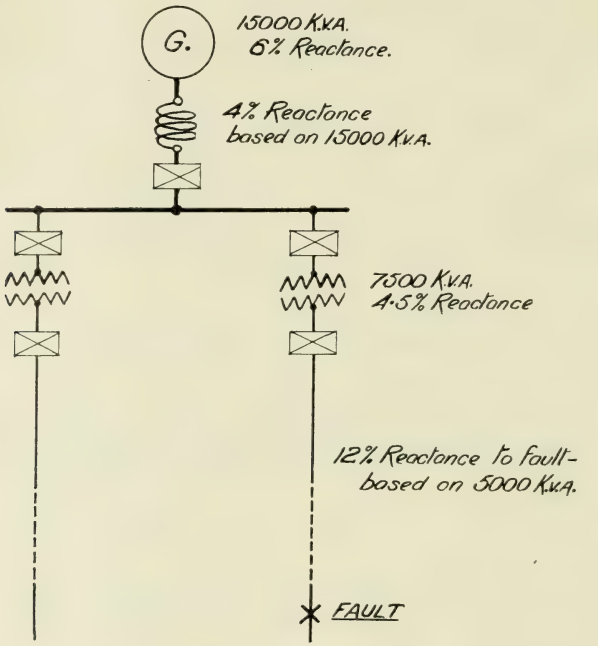
In practically all such calculations the effect of resistance and capacitance is neglected, and only the reactance of the circuits is taken into account. In general, the errors so introduced are of negligible importance, and are on the safe side in any event. This reduces the calculations to applications, more or less difficult, of Ohm's and Kirchoff's laws, using reactance in place of resistance. To illustrate the methods, two simple cases will be assumed, and the calculations carried through for each. (See Problems).

In this calculation it is the value of synchronous impedance or reactance that is assumed for the generator, and hence 600 amps. represents the sustained s.c. current. If the inherent reactance had been used, the initial current would have been obtained, but this value would not have been a great deal higher than 600 amps., due to the limiting effect of the remainder of the system.

A very useful method of approximating this s.c. current, at varying intervals after s.c. occurs, is given by Messrs. Hewlett Mahoney and Burnham in the A.I.E.E. Transactions, 1918. A standard generator characteristic has been decided upon, after careful experimentation, and a series of curves are based upon it. The calculation of the total per cent. reactance of the system is

made exactly as above, and then the value of the transient current, at any instant after s.c. occurs, may be read directly from the curves as a multiple of the rated load current. Problem 2 illustrates the method.

PROBLEM *1.



The given values of reactance are first reduced to a common base, say, generator capacity, 15,000 K.v.a.

Reactance of generator	6.0
" " reactor	4.0
" " transformers	9.0
" " line	36.0
Total reactance to fault	55.0%

Then K.v.a. at point of s.c. $= \frac{15{,}000 \times 100}{55}$

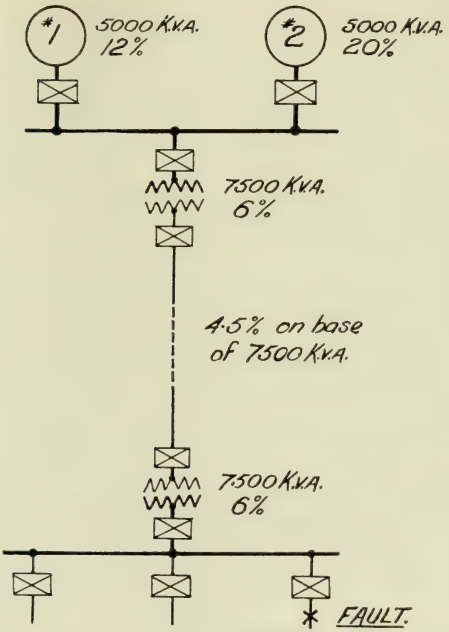
$= 27{,}300$

If line voltage be 26,000 volts

Short circuit current in line $= \frac{27{,}300 \times 1{,}000}{26{,}000 \times 1.73}$

$= 600$ amperes.

PROBLEM #2.



Reduce reactances to total 10,000 K.v.a. base.

Generator No. 1	24.0
" No. 2	40.0
Transformer	8.0
Line	6.0
Transformer	8.0

Reactance of generators in parallel 15%
Then total reactance to fault 37%

From given curves, reading along line of 37% total reactance we find that after 0.1 secs. (say)

current = 2.8 times rated load current.

$$\text{Therefore, short-circuit current} = \frac{2.8 \times \text{Gen. capacity} \times 1000}{1.73 \times \text{line voltage}}$$

$$= \frac{2.8 \times 10{,}000 \times 1{,}000}{1.73 \times 44{,}000}$$

$$= 367 \text{ amps.}$$

Similarly for any other time interval.

(B) *Experimental Determination of s.c. Currents*

With the complicated networks of modern systems, particularly where several separate sources of power are inter-connected, the methods of calculation are extremely lengthy, and, in most cases, not practical. Test methods have therefore been devised, which give much quicker results, of sufficient accuracy for routine short circuit determinations.

The most obvious test method is that in which all the essential elements in the system under consideration are reproduced in a miniature system in true proportion. This kind of test is essentially a miniature a.c. system. To build such a system is an expensive proposition, and the data required is not usually of sufficient importance to justify the expenditure. Several power companies have constructed them, however, one of which, built by the Telluride Power Co., of Provo, Utah, is described by Mr. G. H. Gray in the Institute Transactions, 1917. The General Engineering Laboratory of the General Electric Co. has constructed a somewhat similar miniature system, which has adjustable values of resistance, inductance, and capacitance, so that almost any system may be represented, for purposes of studying s.c. problems.

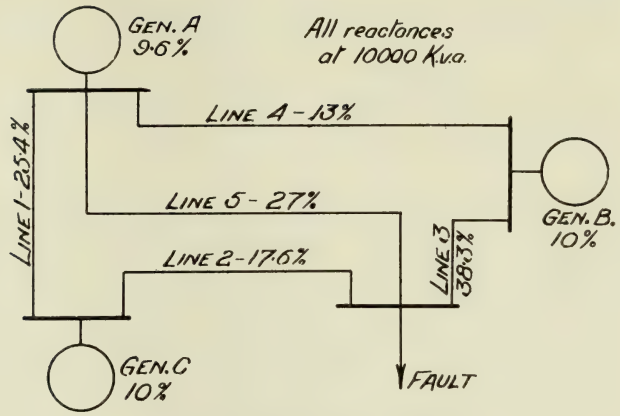
The method has the very great advantage, in that, not only current densities, but also directions of power flow, and phase relations of current and voltage, may be determined by its use. It is particularly valuable in studying phase-to-phase shorts, and wire-to-neutral shorts on grounded neutral systems, problems which cannot be accurately solved by any other means.

The chief disadvantages, other than the expense involved, are the necessity for both resistor and reactor units, and the limitations of low-range a.c. instruments. The miniature apparatus must be either of relatively large current rating to accommodate available instruments, or delicate low-range meters must be provided.

(C) *Short-Circuit Calculating Table*

By far the commonest experimental device used in the treatment of these problems is that commonly known as the "short-circuit calculating table." In this device the three-phase constants of each particular sector of the system are converted to a single-phase equivalent, and that value is represented, to some chosen scale, by a single resistor unit. The whole power system is, in this manner, represented by a single line network of resistor units. A direct current voltage may then be impressed on the composite circuits, at the actual source of power under consideration in the system, and the value of the s.c. currents readily determined by direct observation.

Two general methods are adopted for representing the circuit constants; in the one the per cent. reactance only is considered, and in the other the total per cent. impedance is used. The former method gives very fair results, except on systems which include, either very long transmission lines, or groups of parallel feeders in which the impedance angles of the various feeders differ greatly. In all cases, however, the error is on the right side, giving higher values than the miniature a.c. system. The latter method is particularly suited to systems having parallel connected circuit elements of widely dissimilar impedance angles, but the errors which appear are on the low side, and so are to be avoided. These two general schemes are very fully discussed by O. R. Schurig in his paper "The Experimental Determination of Short-Circuit



TYPICAL SYSTEM LAYOUT

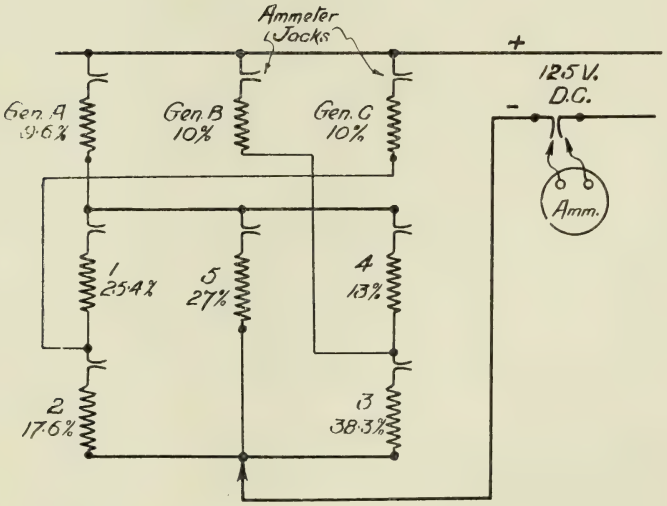


FIG. 2. REPRESENTATIVE SET-UP ON CALCULATING TABLE.

Currents in Electric Power Networks," published in the A.I.E.E. Transactions, 1923.

By reason of the fact that single phase equivalents are used for the calculating table, it can only be used in a consideration of short-circuits involving all three phases. This is not a great objection, however, as the values so obtained are those generally used in the selection of oil circuit-breakers. The method is used extensively, and tables are constructed to represent particular systems, or, more often in fact, they are built with variable resistor units, so that various settings may be used, for predetermining plant and system layouts.

A typical layout, and its representative set-up on the calculating table, is shown in Fig. 2. When the d.c. potential is applied, currents will flow in the network proportional to the actual s.c. currents, and so, knowing the scales employed, the actual values may be readily calculated. In the latest boards, the plugging is done with telephone jacks and cords, making a very compact arrangement, and the junction points are looped through telegraph keys within reach of the operator, so that any required current is obtained by simply pressing the proper key.

4. Conclusion

In a paper of such limited length, as this must of necessity be, the detailed treatment of this subject is obviously impossible. However, several particularly interesting articles are listed in the bibliography, which cover all phases of the subject under discussion. In closing, we would refer the interested reader to these articles, wherein he may discover for himself such further information as he may desire.

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THE HYDRO POWER RESOURCES OF NORTHERN ONTARIO AND THEIR RELATIONSHIP TO THE MINERAL AND PULPWOOD RESOURCES OF THE DISTRICT

Thesis by T. M. Patterson

1. Introductory.

It is intended in the course of this thesis to consider the hydro power situation in a specified area of Northern Ontario and its relation to the development of the mineral and the pulpwood resources of the district. The limits of the above-mentioned area are outlined in the following section and thereafter follows a note on the bases of estimates used, a concise *résumé* of the power rivers in the district, a review of the available power and of the developed power in these rivers, a note on the relationship of this available power to the developed power, the relationship of water power resources of the area to the mining district, the relationship of water power resources of the area to the pulp and paper industry and, finally, the general conclusions.

II. Area Considered.

The southern portion of the area considered takes in all the north shore drainage into Lakes Superior and Huron from the Magpie River on the west to the French River on the east, inclusive. Furthermore, it includes the Ottawa River drainage from Mattawa town to Quinze Lake. The northern portion consists entirely of the Moose River drainage basin. A more comprehensive conception of the territory involved may be obtained by referring to the accompanying Plates I and II. In Plate I the area considered is hatched in red and throughout the thesis this hatched portion will be known as the "Area."

The Height of Land divides the "Area" into two main watersheds: one draining to the north, the other to the south. The northerly basin consists of a long slope which may be conveniently divided into three reaches: the upper, which contains many lakes and has a comparatively gentle slope; the central, in the upper part of which the slope increases considerably, while further down it becomes quite precipitous; and the lower, which flattens out towards James Bay. The watershed is triangular in shape, the base extending along the Height of Land and the apex being at the mouth of the Moose River. The southerly slope, which drains into the Great Lakes system, is short and its rivers tortuous.

Included in the "Area" are numerous rivers containing large amounts of available power, for the most part undeveloped, rich gold, silver, nickel and iron mining areas and vast stretches of pulpwood forests. Large areas of good agricultural land are found in the Clay Belt of the northern slope.

Roughly speaking, there are included in the "Area" some seventy-five thousand square miles of forests, rocky mining country, lakes and rivers but nowhere is native coal found. This fact adds appreciably to the value of the abundant supply of undeveloped hydro-electric power to be found in the district.

III. Basis of Estimates[1].

Basis of power data.

The power data contained in this thesis are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration is definitely known or at least well established. It is reasonable to assume that in such a relatively unexplored section as the "Area" there are various rapids and falls of greater or lesser power capacity not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. Furthermore, no consideration has been given to the power concentrations which are feasible on rivers or portions thereof of gradual slope where economic heads may be created by means of power dams, excepting only at such points as definite studies have been carried out and the results thereof recorded.

Basis of run-off data.

The run-off data are based upon stream measurements made by the Ontario Hydro-Electric Power Commission prior to 1919 and by the Dominion Water Power Branch subsequently. For the Quinze River in the Province of Quebec, which has been included because power developed therein is being transmitted to the Ontario mining areas, the stream measurement data are based upon the records of the Federal Department of Public Works. In some rivers daily records are available for several years, while on others only intermittent records have been secured. Knowing the area in square miles above the gauging station and striking the average discharge figure at this station over a number of years, the run-off per square mile of the watershed above the station may be readily calculated and applied to the areas above the various power sites.

Basis of "Ordinary Minimum Flow" and of "Ordinary Six-Month Flow."

For the sake of uniformity, it is considered desirable to develop

the water power estimates on certain definite bases. Two of these as developed by the Dominion Water Power Branch and used throughout this thesis are "Ordinary minimum flow" and "Ordinary six-month flow."

The "Ordinary minimum flow" is determined by taking the averages of the minimum flow for the lowest two consecutive seven-day periods in each year, over the period for which records are available at any particular station. The "Ordinary six-month flow" is based upon the continuous power indicated by the flow of the stream for six months of the year. To actually determine this flow the months of each year are arranged according to the day of lowest flow in each. The lowest of the six high months is then taken as the basic month, and the average flow of the lowest seven consecutive days in this month determines the maximum for that year. The average of such maxima over the period for which records are available gives the required figure.

Basis of Power Estimates.

The power estimates have been calculated on the basis of 24-hour power at 80% efficiency for conditions of "Ordinary minimum flow" and "Ordinary six-month flow."

IV. Power Rivers.

In the treatment of the power rivers of the "Area" it is intended to touch on the general description, water supply, run-off records, developed storage, undeveloped storage, developed power and undeveloped power. Where these headings have been omitted it should be understood that no definite information is available. In view of the limited permissible length of this thesis and of the extensive field which it endeavours to cover, this section must necessarily be brief. Accordingly, for the sake of brevity, as much general information as possible is given in the next succeeding paragraph, which applies to all or most of the rivers.

The larger part of the "Area" is included in what is termed as the pre-Cambrian shield, a broad "U"-shaped belt of pre-Cambrian rock which stretches around Hudson Bay from Labrador to the Arctic Ocean. A smaller portion in the vicinity of James Bay is composed of Devonian rock. From this it will be seen that the geology through which the different rivers flow is much the same. The rivers flowing southward are tortuous, while those flowing northward have more commonly long stretches of quietly flowing water. The run-off data is based on the records of the Ontario Hydro-Electric Power Commission previous to October, 1919, when the Dominion Water Power Branch took over this work; and since 1919 this data has been based on the records of the latter organization.

Due to the excellent pondage areas above most of the power plants in the district, only minor ice troubles have been experienced.

Available power at the individual sites will be found in Table A appended hereto. Reference should also be made to Plate II. The sites listed, both developed and undeveloped, have been numbered consecutively, beginning with the River Magpie on the southern slope and proceeding eastward and the Missinaibi River on the northern slope and proceeding eastward.

Below is given a brief outline of each river, in order of its respective importance:

Montreal River and Tributaries.

General Description.—The Montreal river is one of the most important tributaries to the Ottawa river drainage and lies largely in the District of Temiskaming. The more important tributaries, ascending the river, are Lady Evelyn River, Spring Creek, Bear River, Sydney Creek and the East and West branches. These feeders all rise in the western and southern lakes of the basin, some being fed in part by springs.

Water Supply.—The drainage area of the Montreal River is 2,575 square miles, exclusive of Lake Timagami, which is now completely diverted for power purposes to the Sturgeon River. The average annual recorded precipitation on this area over a 10-year period was 29.82 inches. Extreme winter conditions ordinarily cause a water shortage in January and February.

Developed Storage.—The storage possibilities are as yet very incompletely utilized, only a relatively few lakes being under control. The actual number controlled is 8 and the total capacity of these is 4.58 billion cubic feet or 105,100 acre feet.

Undeveloped Storage.—There are 11 possible storage lakes in the watershed which have not been developed. The total storage capacity of these lakes is estimated at 5.70 billion cubic feet, or 130,500 acre feet.

Developed Power.—There are several important hydraulic plants in the basin amongst which might be especially mentioned the three pioneer developments of the Northern Ontario Light & Power Co., Ltd., all situated on the lower reaches of the main river. The total hydraulic power installed in the watershed from Table III is 19,190 horse-power.

Undeveloped Power.—Numerous sites in this district remain undeveloped, some of considerable consequence. The total undeveloped power is 23,583 horse-power for six-month development.

Spanish River.

General Description.—The Spanish River, with its tributaries, the Aux Sables and Vermilion Rivers, is an extremely valuable

source of developed and potential power. It is the largest tributary to Lake Huron west of the French River.

Water Supply.—The total area drained by the Spanish River is approximately 5,250 square miles. The watershed, especially in the headwater, possesses a large number of lake expansions. The average yearly run-off for the area over a 6-year period was 18.13 inches.

Developed Storage.—The developed storage in the watershed is sufficient to meet all present demands. Seven lakes are regulated and the International Nickel Co. has a large pondage dam on the river above its plant. The total storage capacity developed is 27.43 billion cubic feet or 629,900 acre feet.

Undeveloped Storage.—The total additional lake area in this watershed, on which it is estimated storage could be developed, is 22,500 acres.

Developed Power.—The total developed power on the Spanish River and its tributaries as taken from Table 3, is 48,020 horsepower.

Undeveloped Power.—There still remains undeveloped a total of 24,110 horse-power based on "Ordinary minimum flow" and 56,180 based on "Ordinary six-month flow."

Abitibi River and Tributaries.

General Description.—The Abitibi is one of the three most important tributaries to Moose River and, together with its tributaries the Black and Frederick House Rivers, comprises almost the entire eastern portion of the Moose River drainage. From the outlet of Lake Abitibi, where the river heads, to its mouth, it has a total length of 228 miles.

Water Supply.—The total area of the Abitibi basin is approximately 11,920 square miles. Records taken at the easterly end of Abitibi Lake over a 27-year period give an average annual precipitation of 26.80 inches. Records at the Iroquois Falls station over a 9-year period give an average of 32.14 inches while the average annual precipitation over 11 years at Cochrane is 25.57 inches.

Developed Storage.—Lake Abitibi is used for artificial storage by the Abitibi Power & Paper Co. in connection with its plants at Twin Falls and Iroquois Falls. Using a storage depth of 6½ feet the reservoir capacity is 52 billion cubic feet or 1,200,000 acre feet.

Undeveloped Storage.—It has been proposed that by building a dam at the head of a small chute 6 miles below Frederick House Lake on the river of the same name, a working storage head of 12 feet could be obtained. This on the lake area of 15 square miles would give a storage capacity of 5.02 billion cubic feet or 115,200 acre feet.

Developed Power.—There are three important developments on the Abitibi, two located on the upper portion of the river, and used for pulp and paper manufacture, and the third on the middle reach

of the river which is now being completed to supply power to the Porcupine mining area. The total installed power on the river, including the new development, is 76,000 horse-power.

The only other development in the watershed is that at Monteith, where the Ontario Government Experimental Farm has developed 35 horse-power on the Driftwood River.

Undeveloped Power.—There are 18 undeveloped water-power sites in the basin, with a total available horse-power of 181,550 at "Ordinary minimum flow" and 291,569 at "Ordinary six-month flow." Nine of these sites are on the Abitibi proper and have available horse-power of 176,128 and 277,017 at the above two flows respectively. The remaining undeveloped power is divided up between the Frederick House and Black Rivers and tributaries.

Mattagami River and Tributaries.

General Description.—The Mattagami River is one of the most important tributaries of the Moose River, the latter being formed by the junction of the Mattagami and Missinaibi. The river heads in a fairly extensive system of lakes just north of the height of land, and has a total length of some 240 miles in which it descends over 1,000 feet. It has two main tributaries, the Groundhog and Kapuskasing Rivers, which enter from the west.

Water Supply.—The total drainage area of the Mattagami and tributaries is 14,306 square miles.

The total annual precipitation for 1920 at two different stations in the district was 26.71 inches and 15.90 inches respectively, but as 1920 was a year of very low precipitation this should probably be increased to obtain the average annual figure.

Developed Storage.—The Northern Canada Power, Limited, operates five storage reservoirs in the upper Mattagami basin. These five constitute the total regulation in this watershed with total storage capacity of 12.82 billion cubic feet or 294,720 acre feet.

Undeveloped Storage.—Very little definite information is available concerning the storage possibilities which appear to exist on this river. It is estimated that the Kapuskasing and Red Pine Lakes and the Kapuskasing River could be regulated to give a total storage capacity of 2.17 billion cubic feet or 49,800 acre feet.

Developed Power.—Two thousand nine hundred horse-power are developed on the Kapuskasing and its tributary the Kebwaska; while 37,150 horse-power are developed on the Mattagami River proper. This gives a total of 40,050 developed horse-power for the watershed.

Undeveloped Power.—There are 11 undeveloped sites on the Mattagami, with available power of 113,640 horse-power at "Ordinary minimum flow" and 220,110 horse-power at "Ordinary six-month flow"; 2 on the Groundhog with available power of 2,162 and 5,500 horse-power at these flows; 7 on the Kapuskasing totalling

6,126 horse-power and 14,235 horse-power and one on the Trout River, a tributary to the Kapuskasing, with 304 and 714 horse-power at the above-mentioned flows. Thus there is a grand total of 122, 232 horse-power at "Ordinary minimum flow" and 240,559 horse-power at "Ordinary six-month flow" in the watershed, which is as yet undeveloped.

Missinaibi River and Tributaries.

General Description.—The Missinaibi is one of the three main tributaries to the Moose River, the latter being formed by the junction of this river and the Mattagami. The stream heads in Missinaibi Lake near the Height of Land, and in its total length of 244 miles descends some 1,050 feet. The river's main tributary, the Opasatika, joins it in its lower section.

Water Supply.—The total drainage area of the Missinaibi is 9,368 square miles, including the 2,010 square miles drained by the Opasatika. There are no precipitation stations in this district and those nearby have not records over a sufficient period to establish an average annual figure.

Undeveloped Power.—Information regarding falls and rapids is not very complete especially on the tributaries. However, the river offers several possibilities, some of which seem to be particularly attractive. The total undeveloped water-power in this watershed as shown in Table A in the appendix hereto, is estimated at 12,648 horse-power at "Ordinary minimum flow" and 28,094 horse-power at "Ordinary six-month flow."

Sturgeon River.

General Description.—The Sturgeon River is the largest feeder of Lake Nipissing. It is 140 miles long and enters the lake from the north where it drains a large area dotted with streams and lakes of various sizes.

Water Supply.—The Sturgeon River drainage area is 2,676 square miles in extent, a considerable portion of which is lake surface. Approximately one-third of this area is occupied by the Timagami River basin which is tributary to the Sturgeon. The mean annual precipitation in the area is taken as 29.82 inches, this being the average of 10 years observations at Montreal River.

Developed Storage.—Considerable regulation is carried on in the lakes of this basin under the control for the most part of the Spanish River Pulp and Paper Mills, Ltd. The capacity of the 11 lakes regulated is 25.97 billion cubic feet or 596,700 acre feet.

Undeveloped Storage.—So far as is known, no large undeveloped storage sites exist in the watershed, although it is possible to create storage on some of the smaller lakes, of which there are several. It is also possible to raise many of the existing dams and

increase the present working storage depths.

Developed Power.—The Spanish River Pulp and Paper Mills, Ltd., has installations amounting to 18,590 horse-power on this river in connection with the company's mills at Sturgeon Falls.

Undeveloped Power.—There are thirteen known undeveloped sites in the Sturgeon watershed, of which eleven are on the main stream and two on its tributary, the Timagami. It is estimated that these sites, if developed, could supply 8,266 horse-power at "Ordinary minimum flow" and 15,403 horse-power at "Ordinary six-month flow."

Blanche River and Tributaries.

General Description.—The Blanche River drains a considerable agricultural territory west of the River Quinze and enters the north end of Lake Temiskaming through four outlets.

Water Supply.—The drainage area of the Blanche River is approximately 2,000 square miles. An average annual precipitation of 29.73 inches recorded at Haileybury over a 20-year period may be considered as applicable to this district.

Developed Storage.—Storage is at present being maintained on two lakes on the east and west branches of the river respectively. The total storage capacity of these reservoirs is 1.97 billion cubic feet or 45,100 acre feet.

Undeveloped Storage.—There are several good-sized lakes and a large number of small ones in the watershed which could be utilized for storage. The possible draught on these lakes is not known but the total surface area of eleven of them is some 18,800 acres.

Developed Power.—Power installations in the Blanche watershed total 2,710 horse-power.

Undeveloped Power.—At a total of 19 undeveloped sites it is estimated there is 6,833 horse-power at "Ordinary minimum flow" and 14,848 at "Ordinary six-month flow."

Upper Ottawa River.

General Description.—The upper Ottawa basin above the head of Lake Temiskaming comprises an area of some 9,700 square miles.

Water Supply.—The water supply is derived chiefly from forest-covered Laurentian country interspersed with a great many lakes. Precipitation records indicate for the upper basin an average annual precipitation of about 32 inches.

Developed Storage.—The total storage capacity of the three lakes regulated in this district is 113.38 billion cubic feet or 2,604,-800 acre feet.

Undeveloped Storage.—There are a large number of lakes in

the watershed which might be utilized for storage. Thirteen of these would provide a storage capacity of 98.58 billion cubic feet or 2,263,680 acre feet.

Developed Power.—Within the limits of the "Area" considered herein there is one development of 20,000 horse-power on that portion of the Ottawa known as the Quinze River.

Undeveloped Power.—At 4 undeveloped sites there is estimated to be a total of 95,900 horse-power at "Ordinary minimum flow" and 198,010 at "Ordinary six-month flow."

South River.

General Description.—The South River is a small but valuable power stream in the district of Parry Sound, flowing northwest into Lake Nipissing.

Water Supply.—The drainage area of the South River is 350 square miles. Records of precipitation at the Montreal River Meteorological station are applicable here and over a 10-year period give an average annual precipitation of 28.13 inches.

Developed Storage.—The Ontario Hydro-Electric Power Commission controls storage on 7 lakes with an existing combined capacity of 23,400 acre feet, or 1.02 billion cubic feet.

Undeveloped Storage.—There are very few known undeveloped storage sites that are of value.

Developed Power.—Installations totalling 3,975 horse-power are installed on the South River and tributaries.

Undeveloped Power.—It is estimated that at a total of 6 sites 1,129 horse-power could be developed at "Ordinary minimum flow" and 3,059 horse-power at "Ordinary six-month flow."

French River and Tributaries.

General Description.—The French River flows into Georgian Bay and is one of the main contributors to the St. Lawrence system. It is joined at its mouth by the Wanapitei River.

Water Supply.—The drainage area of the French River is 7,377 square miles including the Wanapitei basin. The mean annual precipitation in the watershed, over a 10-year period, has been estimated at 29.82 inches.

Developed Storage.—Storage capacity being operated on the Wanapitei River amounts to 21.6 billion cubic feet or 496,000 acre feet.

Undeveloped Storage.—Owing to possible interference of navigation on the French River, storage on this river for power purposes has not been allowed.

Developed Power.—There is a total turbine capacity of 9,900 horse-power installed at 2 sites on the Wanapitei River.

Undeveloped Power.—There is a total undeveloped power on

the French and Wanapitei Rivers of 21,415 horse-power at "Ordinary minimum flow" and 37,849 at "Ordinary six-month flow."

Mississagi River.

General Description.—The Mississagi River drains southward into Lake Huron. The approximate area of the watershed is 3,717 square miles.

Water Supply.—The average annual precipitation is approximately 30 inches.

Undeveloped Power.—There are 17 undeveloped sites on the river. It is estimated that these would provide 31,486 horse-power at "Ordinary minimum flow" and 66,089 horse-power at "Ordinary six-month flow."

Matabitchuan River.

General Description.—The Matabitchuan River drains into Lake Temiskaming within a few yards of the Montreal River.

Water Supply.—The drainage area of the Matabitchuan is 363 square miles containing many moderately-sized lakes. The average annual rainfall for the area is placed at 29.82 inches.

Developed Storage.—There is a total storage capacity of 6.51 billion cubic feet or 149,600 acre feet developed in this basin.

Undeveloped Storage.—There are additional lakes in the basin on which storage could be developed but figures for the capacity of these are lacking.

Developed Power.—The Northern Ontario Light & Power Co. have a turbine installation of 11,000 horse-power on this river.

Mattawa and Amable du Fond Rivers.

General Description.—The Mattawa, together with the flow from its tributary the Amable du Fond, enters the Ottawa River at the village of Mattawa.

Water Supply.—This watershed covers 880 square miles. Records over a 10-year period show an average annual precipitation of 32.88 inches.

Developed Storage.—A total storage capacity of 1.64 billion cubic feet or 37,800 acre feet is developed in this basin.

Undeveloped Storage.—Storage to the amount of 14.93 billion cubic feet or 342,600 acre feet is available but undeveloped in the watershed.

Developed Power.—Two hundred and eighty-six horse-power are installed near Mattawa.

Undeveloped Power.—There is a total of 4,465 horse-power at "Ordinary minimum flow" and 9,714 at "Ordinary six-month flow" undeveloped in the watershed.

Michipicoten and Magpie Rivers.

General Description.—The Michipicoten, with a drainage area of 2,008 square miles, is joined near its mouth by the Magpie River, with a drainage area of 718 square miles, and the two together flow into Lake Superior.

Water Supply.—The average annual precipitation is approximately 31.0 inches.

Undeveloped Storage.—Storage is feasible on Dog Lake to the extent of 4.46 billion cubic feet or 102,400 acre feet.

Developed Power.—Turbine installations on these rivers total 4,200 horse-power.

Undeveloped Power.—Undeveloped power is available to the extent of 8,793 horse-power at "Ordinary minimum flow" and 30,302 at "ordinary six-month flow."

Montreal, Agawa, Batchawana, Sand, Chippawa and Goulais Rivers.

General Description.—These are all comparatively small streams and are north shore tributaries to Lake Superior at its eastern end.

Water Supply.—The total area of their drainage basins is approximately 3,075 square miles. A study of precipitation records in adjacent territory indicates that an average annual precipitation of 30 inches may be expected.

Undeveloped Storage.—It is estimated that storage to the amount of 5.57 billion cubic feet or 128,000 acre feet can be obtained on the Montreal River.

Undeveloped Power.—There is a total of 8,363 horse-power at "Ordinary minimum flow" and 29,962 at "ordinary six-month flow" undeveloped on these various rivers. For individual rivers and sites see Table A in the Appendix.

Whitefish River.

General Description.—This river, which is really a series of lakes, enters Lake Huron at the Bay of Islands.

Water Supply.—The total drainage area of the river is 360 square miles, of which much is lake area. The average annual precipitation is approximately 31 inches.

Undeveloped Power.—There are 4 undeveloped sites on the river, totalling 961 horse-power at "Ordinary minimum flow" and 2,303 horse-power at "Ordinary six-month flow."

V. Available Power in the "Area."

Probably the most direct method of presenting in concrete form the *total available power resources* of the "Area" under natural conditions is by means of a table. This will necessitate an estimate

of the power available under natural conditions at the present developed sites deduced on the same basis as the estimates of the power available at the undeveloped sites are deduced in the preceding section of this thesis. For example, at plant No. 57 on the Spanish River, the Huronian Co., Ltd., has an installation of 20,600 h.p., but the power available calculated for "Ordinary minimum flow" and "Ordinary six-month flow" is 7,913 h.p. and 12,464 h.p. respectively.

A complete compilation of the available power will be found in Table A[3] appended hereto. In this table are recorded for each individual power site, its name (if named), its location, the head in feet, the ordinary minimum and the ordinary six-month flow and corresponding power, as well as any special comments as to development, etc. On account of its length, it has been inserted at the end of this thesis as an appendix. A summary follows hereunder in Table No. 1:

From this table it is found that the available power in the "Area" reaches the surprising totals of 727,591 h.p. for "Ordinary minimum flow" and 1,360,189 h.p. for "Ordinary six-month flow." The Abitibi River, with 335,946 h.p., the Mattagami, with 242,170 h.p., and the Quinze (in Quebec), with 176,010 h.p. available, together make up more than one-half the total for "Ordinary six-month flow." The figure given in the table for the St. Mary's River comprises only one-half the total power available on the river. The other half belongs to the United States. It will be seen by examining Plate I, in conjunction with Table 1, that the power is fairly well distributed over the "Area."

VI. Developed Power in the "Area."

In turning to the matter of developed power in the "Area," it is proposed in this section to treat only of the *general* phases, since the relationship of the developed power to the mining and pulp and paper industries will be dealt with in greater detail in subsequent sections.

The developed power may be analysed on different bases, firstly, as to type of development, secondly, as to location or distribution, and thirdly, as to ownership.

(1) *Development of Hydro Power.*

During the year 1923 the total hydraulic power installation of Canada was increased by over a quarter of a million horse-power, and at the beginning of the present year (1924) had reached the imposing total of 3,227,414 h.p.[4] The growth of installed power in the "Area" may best be realized by means of a table. Table No. **2** hereunder shows the growth by years since 1890.[5]

TABLE NO. 1—AVAILABLE POWER IN SPECIFIED AREA OF NORTHERN ONTARIO (BY RIVERS)

River	Tributary to	Available H.P. Ord. Min. Flow	Available H.P. Ord. Six-Month Flow
Magpie	Michipicoten River	4,310	8,620
Shikwamkwa	" "	883	3,151
Michipicoten	Lake Superior	6,183	22,097
Sand	" "	190	655
Agawa	" "	507	1,808
Montreal	" "	5,767	20,681
Batchawana	" "	371	1,329
Chippawa	" "	233	832
Goulais	" "	2,196	4,647
St. Mary's	" Huron	(1) 53,600	(2) 65,800
Mississagi	" "	31,486	66,089
Little White	Mississagi River	451	945
Spanish	Lake Huron	36,820	59,499
Aux Sable	Spanish River	4,790	14,197
Vermillion	" "	3,840	17,276
Onaping	Vermillion River	1,619	7,293
Whitson	" "	....	....
Whitefish	Lake Huron	961	2,303
Wahnepetei	" "	9,221	13,835
Sturgeon	" Nipissing	12,487	23,275
Timagami	Sturgeon River	3,268	6,088
French	Lake Huron	15,750	29,350
South	" Nipissing	2,234	6,066
Guiness	South River	....	....
Trout Cr.	" "	....	....
Quinze	Lake Temiskaming	69,580	176,010
Ottawa	St. Lawrence River	51,170	84,860
Blanche	Lake Temiskaming	7,193	15,631
Victoria Cr.	Blanche River	....	....
Raven	" "	332	724
Wright Cr.	" "	5	12
Montreal	Ottawa River	19,982	43,387
Bear	Montreal River	81	177
Lady Evelyn	" "	1,420	3,088
Mattawa	Ottawa River	1,325	2,912
Amable du Fond	Mattawa River	3,353	7,302
Matabitchuan	Ottawa River	2,978	6,439
Missinaibi	Moose River	9,893	21,219
Opasatika	" "	2,755	6,875
Kapuskasing	Mattagami River	7,226	16,835
Trout	Kapuskasing River	304	714
Kebwashi	" "	....	....
Groundhog	Mattagami River	2,162	5,500
Mattagami	Moose River	129,490	242,170
Black	Abitibi River	493	1,052
Shallow	Black River	38	83
White Dog	" "	45	100
Driftwood	" "	....	....
Frederick House	Abitibi River	4,846	13,317
Abitibi	Moose River	216,653	335,946
	Totals	727,591	1,360,189

Notes (1) and (2).—Equal amounts are available in the U.S.

TABLE 2.—GROWTH OF DEVELOPED WATER-POWER IN THE "AREA"

1	2	3
Date	Installed during Year H.P.	Total at end of Year H.P.
1890 and before	65	65
1891	..	65
1892	..	65
1893	..	65
1894	..	65
1895	75	140
1896	286	426
1897	..	426
1898	..	426
1899	..	426
1900	6,300	6,726
1901	....	6,726
1902	7,290	14,016
1903	....	14,016
1904	10,870	24,886
1905	8,700	33,586
1906	600	34,186
1907	1,600	35,786
1908	4,100	39,886
1909	12,500	52,386
1910	15,425	67,811
1911	23,210	91,021
1912	15,000	106,021
1913	8,200	114,221
1914	26,880	141,101
1915	5,500	146,601
1916	9,300	155,901
1917	21,250	177,151
1918	21,770	198,921
1919	1,600	200,521
1920	250	200,771
1921	36,050	238,821
1922	....	238,821
1923	13,250	250,071
1924	46,750	296,821

These figures afford striking evidence of steady and continuous growth in the utilization of the water power resources of the "Area." A total installation of 65 horse-power at the end of 1890, increased to 6,726 horse-power by the end of 1900, to 67,811 horse-power by the end of 1910, to 200,771 horse-power by the end of 1920, and to 296,821 by the end of 1924. This last amount includes the 24,000 horse-power development of the "Hollinger" which is under construction but which should be completed before the end of the year. It also includes the 20,000 horse-power development just completed at Kekek Falls on the Quinze River. While this development is over the Quebec boundary, the main market for the power is the gold mining area in Ontario.

There is also at the present time one other development under construction,—at Wendigo Falls on the Blanche River. Associated

Gold Fields, Ltd., is installing turbines with a total capacity of 6,000 horse-power at this site.

Data concerning the individual power plants in the "Area" are listed below in Table No. 3.[6] Reference should also be made to Plate II for location.

Two hundred and ninety-six thousand eight hundred and twenty-one horse-power developed is a strikingly large total, especially when consideration is given to how sparsely settled is this portion of the country. It is indicative of the importance of power to the industries of the district.

Analysis with regard to type of development.

Under this heading the stations are classified as "Central Electric Stations" or as "Private Purpose Plants." By "Central Electric Stations" are intended stations developing power for sale or distribution to other users; by "Private Purpose Plants" are intended stations developing power for use by the company or organization owning or controlling the said stations.

In Table No. 3, of the 296,821 installed horse-power, 172,124 is classed under Central Electric Stations and the remaining 124,697 horse-power under Private Purpose Plants. In other words, 58% of the installed power of the "Area" is in plants classed as "Central Electric Stations," while the other 42% is for private use.

Analysis with regard to Distribution.

(1) *By Rivers.*—It is found by an examination of the table that, of the 296,821 horse-power installed in the district, 255,300, or 86% is installed on 7 or 29% of the rivers as follows: Abitibi, 76,000; St. Mary's, 42,450; Spanish, 41,920; Mattagami, 37,150; Quinze, 20,000; Montreal, 19,190, and Sturgeon, 18,590 horse-power. The remaining 41,521 horse-power is divided up among 17 rivers, in amounts varying from 30 horse-power on the Wright, to 11,000 horse-power on the Matabitchuan.

(2) *By Districts.*—On Plate II it will be noticed that power is transmitted from the various power plants to several different centres and it is with regard to these centres that the following analysis is made.

Porcupine.—There are at present four plants supplying this district with its power. These are Nos. 223, 234 and 235 on the Mattagami River and No. 173 on the Montreal River. These plants have a total installation of 32,100 horse-power. With the completion of the Hollinger (No. 257) and Quinze River (No. 138) developments with their attendant transmission systems, the Porcupine field will have an additional 44,000 horse-power available.

TABLE 3.—DEVELOPED WATER-POWER IN THE "AREA"

River	Site No.	Site Name	Location	Head in Feet	Installed H.P.	Type of Dev.	Owner
1	2	3	4	5	6	7	8
Magpie	6	Steep Hill Falls	Steep Hill Falls	68	2,600	P.P.	Algoma Steel Corp. Ltd.
Michipicoten	13	High Falls	6 miles above mouth	125	1,600	CES.	Algoma Power Co.
St. Mary's	29	Sault Ste. Marie	At Sault Ste. Marie	18	14,400	P.P.	Great Lakes Power Co.
					28,050	CES.	Lake Superior Paper Co.
Spanish	57	High Falls	3 miles above turbine	85	21,300	P.P. & CES.	Huronian Co. Ltd. P.P 64%, CES. 36%
"	58	Nairn Falls	Above Nairn Sta., C.P.R.	29	4,800	CES.	Lorne Power Co.
"	59	Espanola Falls	At Espanola	63	15,820	P.P.	Spanish River Pulp and Paper Mills Ltd.
Vermilion	81	Lorne Falls	4 miles from Nairn Centre	70	4,800	CES.	Lorne Power Co.
"	82	McPherson Falls	16 miles west of Sudbury	27	1,300	P.P.	Sudbury Flour Mills Ltd.
Whitson	88		At Chelmsford		65	P.P.	Adelard Chenies
Wahnapetei	107		1.5 miles below Wahnapetei Sta.	53	6,300	CES.	Wahnapetei Power Co.
"	108		At McVitties Stn., C.N.R.	38	3,600	CES.	Wahnapetei Power Co.
Sturgeon	120	Sturgeon Falls	In town of Sturgeon Falls	36	13,390	P.P.	Spanish River Pulp and Paper Mills Ltd.
"	121	Smoky Falls	14 miles above L. Nipissing	35	5,200	P.P. & CES.	Spanish River Pulp and Paper Mills Ltd. P. P., 75%, C.E.S. 25%
South	133	Bingham Falls	Lot 22, Con. 13, Hamsworth Tp.	45	1,200	CES.	Ont. H.-E. Power Com.
"	134		Near South River Stn.	64	460	P.P.	Ward & Richards
"	135		2½ miles above Nipissing	90	2,200	CES.	Ont. H.-E. Power Com.
Guiness	136		At Powassan	28	40	P.P.	Alf. Mitchell
Trout Creek	137		At Trout Creek	28	75	P.P.	Toussler Bros.
Quinze	138	Kekek	Below Quinze Lake	90	20,000	CES.	Northern Canada Pr. Co.
Blanche	162	Charlton Falls	At Charlton	37	1,080	CES.	Nor. Ont. Light and Power Co.

River	Site No.	Site Name	Location	Head in Feet	Installed H.P.	Type of Dev.	Owner
1	2	3	4	5	6	7	8
Raven	164	Raven R. Falls	Between Lardu and Raven Lakes	96	1,600	P.P.	Assoc. Gold Fields Co.
Wright	165		Nedelec Que.	12	30	P.P.	D. Cloutier
Montreal	173	Indian Chutes	North of Elk Lake, Ont.	47	4,300	CES.	Gt. Nor. Power Co.
"	174	Hound Chutes	6 miles south of Cobalt	325	5,340	CES.	Nor. Ont. Light & Power Co.
"	175	Ragged Chutes	4 miles east of Johnston Stn.	48	5,500	CES.	Nor. Ont. Light & Power Co.
"	176	Fountain Falls	9.5 miles south of Cobalt	30	3,000	CES.	Nor. Ont. Light & Power Co.
"	177	Hangingstone Falls	5 miles from Gowganda	67	250	CES.	South Bay Power Co.
"	178	Gowganda Falls	At outlet of Gowganda Lake	29	800	C.ES	Gowganda Power Co.
Bear	179	Elk Lake	In town of Elk Lake	14	350	CES.	Elk Lake Power Co.
Mattawa	187		2 miles from Mattawa	12	286	CES.	Mattawa El. L. & Power Co.
Matabitchuan	195		At Matabitchuan Portage	312	11,000	CES.	Nor. Ont. L. & P. Co.
Kapuskasing	217	Spruce Falls	Kapuskasing	30	2,500	CES.	Spruce Falls Co.
Kabakwaska	219		2 miles from Chapleau	50	400	CES.	J. McNaustin
Mattagami	223	Sturgeon Falls	Mahaffy Tp., Temiskaming D.	42	8,000	CES.	Nor. Can. Power Co.
"	234	Wewaitin Falls	At foot of Kenogamissi Lake	125	14,900	CES.	Nor. Can. Power Co.
"	235	Sandy Falls	6 miles N.W. of Timmins	32	4,900	CES.	Nor. Can. Power Co.
"	236	Smooth Rock Falls	Town of Smooth Rock Falls	36	9,350	P.P.	Mattagami Pulp & Paper Co.
Driftwood	242		At Monteith	10	35	P.P.	Ont. Govt. Exp. Farm
Abitibi	255	Twin Falls		60	24,000	P.P.	Abitibi Power & Paper Co.
	256	Iroquois Falls		425	28,000	CES.	Abitibi Power & Paper Co.
	257	Island Falls	40 miles north of Cochrane	60	24,000	P.P.	Hollinger Cons. Gold Mines
					296,821		

Column 2 gives the same number to the plant as given to it in Table No. A.
Column 7—C.E.S. stands for Central Electric Station and P.P. stands for Private Purpose Plant.

Under Construction

Blanche	Wendigo Falls	Wendigo	6,000	CES P.P.	Associated Gold Fields Ltd.

Kirkland-Larder-Cobalt District.—Five plants supply the power needs of this area. Three of these, Nos. 174, 175 and 176, are on the Montreal River and transmit power to the silver mining operations at Cobalt as well as to the Kirkland Lake Gold area. The fourth plant (No. 162) is on the Blanche River and also serves the Kirkland Lake gold mining industry. The fifth plant (No. 164) is on Raven River and supplies power to the Larder Lake gold field. The total installation of the above five plants is 16,520 horse-power.

Sudbury District.—The nickel mining industry around Sudbury is supplied with power from two plants on the Spanish River (Nos. 57 and 58); one on the Vermilion (No. 81), and two on the Wahnapitae River (Nos. 107 and 108). The total installation in these five plants is 40,800 horse-power and a very high percentage of their output is used in the mining and smelting operations of the copper and nickel industry.

Sault Ste. Marie.—At this point there is installed by two companies on the Canadian side of the St. Mary's River a total of 42,450 horse-power. These two developments are listed in Tables A and 3 and on Plate II as site No. 29.

Reference to Plate II shows the scattered layout of the power plants serving the pulp and paper industry in the "Area." The location of these plants for the most part coincides with the location of the mills and pulpwood limits of the companies.

Analysis with Respect to Ownership.

It will be seen from Column 8 of Table 3 that many companies operate more than one power plant. Thus the Northern Ontario Light & Power Co. operates plants 174, 175 and 176 on the Montreal River, and 162 and 195 on the Blanche and Matabitchuan Rivers respectively. The total installation of this Company's five plants is 25,920 horse-power. The Northern Canada Power Co. has four power plants. Three of these, Nos. 223, 234 and 235, are on the Mattagami River; the fourth, No. 138, is on the Quinze River. The total installation of these four is 47,800 horse-power. The Spanish River Pulp & Paper Mills, Ltd., operates plants 59, 120 and 121, with a total installation of 34,410 horse-power. Similarly the Abitibi Power & Paper Co. operates two power plants with a total installation of 52,000 horse-power. In addition to the above, the Wahnapitae Power Co., the Lorne Power Co. and the Hydro-Electric Power Commission each operate two stations.

(2) *Transmission and Distribution of Power.*

In this section it is proposed to deal with the existing transmission and distribution systems in the "Area." By the transmission of power is meant the conveying of power at high voltage from the

power plant to the locality in which it is to be used, while by the distribution of power is intended the retailing of the power to the different users at a much lower voltage.

The large majority of transmission lines in the "Area" (see Plate II) are for the purpose of supplying power to the mining industry. Thus the Northern Canada Power Co. has approximately 65 miles of transmission lines supplying the Porcupine area from its three plants on the Mattagami River and has recently completed a 125-mile[7] line from its Quinze River station to the same field. The Great Northern Power Co. also transmits power to Porcupine from its Montreal River development, a distance of some 60 miles. In the Larder Lake and Cobalt districts the Northern Ontario Light and Power Co. has some 163 miles of transmission lines from which power is distributed to the gold and silver mines and for street and residential lighting. The International Nickel Co. operates 40 miles of wooden pole transmission lines from plant No. 57 to Copper Cliff, Creighton Mine and O'Donnell at 34,000 volts. The distribution system consists of 15 miles of pole lines, primaries 2,200 volts and secondaries 110 volts.[8] The Wahnapitae Power Co., Ltd., owns 16 miles of wooden pole transmission lines connecting its plants Nos. 107 and 108, and 10 miles of wooden pole lines leading into Sudbury. In Sudbury the Company's distribution system consists of 4 miles of wooden pole lines; primaries 2,200 volts, secondaries 110 and 550 volts.[9] The Lorne Power Co., Ltd., transmits power over 78 miles of wooden pole lines from its two plants No. 58 and No. 81 to substations at Worthington, Mond, Garson, Levack and Coniston at 44,000 volts.[10] Other companies and their transmission systems are: Associated Gold Fields, 15 miles; Algoma Power Co., 6 miles; Algoma Steel Corporation, 20 miles, and the Spanish River Pulp and Paper Mills, Limited, 10 miles. Furthermore, the Hollinger Consolidated Gold Mines intends transmitting power from its new development on the Abitibi River to Porcupine, a distance of some 80 miles.

(3) *Future Trend in Power Development.*

Modern tendency in the practice of hydro power development and transmission is towards amalgamations into what have been termed super power systems. A very good example of this is that of the Ontario Hydro-Electric Power Commission, which has absorbed practically all competition in its territory. The principal advantages to be secured from such amalgamations are:

(1) A more reliable supply of power due to the fact that if one plant goes out of commission the other plants in the system are available to make up, at least to some extent, the deficiency.

(2) A more reliable power service owing to the interconnection of transmission lines.

(3) A more stable power market due to broader and more diverse uses of power.

(4) Elimination of unnecessary duplication of transmission lines and other equipment with their contingent capital investment for which annual charges must be provided.

Within the "Area" considered herein, in the early days, water powers were developed to supply particular mining and pulp and paper districts. As the development of the country proceeded, these plants, along with new developments, transmitted power into new territories. This resulted in duplication of transmission and distribution systems and the advisability of merging the different systems soon became evident.

Recent press reports indicate that such a merger is being considered among the northern power interests at the present time. Quite recently it has been reported that the Northern Canada Power Company will absorb the Great Northern Power Company, and ultimately is likely to bring the Northern Ontario Light & Power Company, which is virtually under the same control, into the merger.

VII. Relationship of Available Power to Developed Power in the Area.

It is desirable to establish the relationship existing between turbine installation and available resources in the "Area."

First, it might prove of interest to develop the relationship for the Dominion as a whole and later to compare this figure with that for the "Area."

The available power expressed as stream capacity cannot be directly compared with the developed water-power as represented by turbine horse-power installed, since the installed horse-power always considerably exceeds the calculated stream capacity. The installed horse-power required to utilize a given stream capacity depends upon the load factor, as well as the pondage facilities. It must also provide for spare units.

An analysis of Canadian water-power plants scattered from coast to coast, concerning which complete data are available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30% greater than the six-month flow maximum power. Applying this to the 32,076,000 h.p., which is the total for the Dominion, dependable for at least six months of the year, indicates that Canada's *present recorded water-power resources* will permit of a turbine installation of 41,700,000 h.p.[11]

The total installation to date in waterwheels and turbines throughout the Dominion is 3,227,414 h.p.[12] In other words, the present turbine installations represent only 8% of the recorded water-power resources.

A similar analysis of the plants throughout the "Area" which are completely installed, shows a turbine installation 37% greater than the power indicated as being available for six months of the year. This six months available power, 1,360,189 h.p. as totalled in Table 1, if developed on the basis at present obtaining in the "Area," would permit of a turbine installation of 1,863,460 h.p.

The present installation within the "Area" is 296,821 h.p. or only 16% of the possible installation as established in the foregoing paragraph. It is apparent, therefore, that the power resources of the district are sufficient to permit of greater expansion of the Northern Ontario industries.

VIII. The Relationship of Water-Power Resources of the "Area" to the Mining Industry.

Canada is fortunate in the possession of areas where mineral wealth and water-power lie in close proximity. This is in no place better exemplified than in the "Area" considered herein, where there are large gold, silver and nickel mines in close proximity to nearly one and a half million horse-power available for six months of the year.

It will be seen from the following pages that the mineral industry of the "Area" has three outstanding characteristics, viz., rapid growth, proximity of water-power and the domination of the world's markets as regards certain metals, nickel and cobalt.[13] As a producer of gold, Ontario now stands third among the countries of the world, being exceeded only by the Union of South Africa and the United States of America. During the last twenty years Ontario has also taken a leading place as a producer of the sister metal, silver. The more important of the Province's gold and silver mines are located in this "Area."

In no other part of the world to-day is there more intense interest in the search for and the development of mining properties. The success achieved in recent years, and the large areas awaiting the prospector and the miner, lead to the belief that the industry in this section of the province offers great promise for the future.

The Mineral Resources of the "Area."

Gold.—The discovery of the world-famous silver deposits of Cobalt in 1903 during the construction of the Temiskaming and Northern Ontario Railway resulted in intense and widespread prospecting in this district. Prospectors spread out from the railway line as it was extended northwesterly from Cobalt towards Cochrane, and made successive discoveries of gold-bearing ore, of which the greatest were those of the Porcupine in 1909, followed by Kirkland Lake in 1912. The finding of these gold-bearing areas has changed the status of gold mining in Ontario from one of insignificant proportions to that of an industry which is attracting the attention of the mining world.[14]

The Porcupine gold camp includes such well known mines as the Hollinger Consolidated, Dome, McIntyre, Vipond Consolidated and Clifton Porcupine. The Kirkland Lake camp includes the Wright-Hargreaves, Kirkland Lake, Teck-Hughes, Lake Shore and Kirkland Lake Proprietary mines. Other active areas in the district are Larder Lake, Night Hawk Lake, Matachewan, Abitibi Lake, Goudreau and Shining Tree.

In Table No. 4,[15] hereunder, the value of the total gold output of the province, exclusive of premium, is given; also that from Porcupine and Kirkland Lake, beginning in 1910 and 1913 respectively.

Table No. 4—Progressive Gold Output from Porcupine and Kirkland Lake

Year	Total Production in Dollars	Porcupine		Kirkland Lake	
		Dollars	Per Cent.	Dollars	Per Cent.
1892					
1909	2,509,492				
1910	68,498	35,539	51.8		
1911	42,637	15,437	36.2		
1912	2,114,086	1,730,628	81.8		
1913	4,558,518	4,294,113	94.1	65,260	1.2
1914	5,529,767	5,190,794	93.8	114,154	2.0
1915	8,501,391	7,536,275	88.6	551,069	6.5
1916	10,339,259	9,397,536	90.8	702,761	6.8
1917	8,698,735	8,229,744	94.5	404,346	4.6
1918	8,502,480	7,767,907	91.4	632,007	7.4
1919	10,451,709	9,941,804	95.1	486,809	4.7
1920	11,686,043	10,597,573	90.7	1,033,478	8.8
1921	14,624,085	13,095,630	89.5	1,524,851	10.4
1922	20,674,109	18,505,134	89.5	2,159,231	10.4
1923	20,082,586	17,313,115	86.2	2,647,630	13.2
Totals	128,383,395	113,651,229	88.5	10,321,596	8.0

As will be seen from the table, there has been a gratifying continuous yearly growth in the output of gold since 1910, when the Porcupine mills began producing bullion, except in 1911, owing to forest fires, in 1917 and 1918 when the decrease was due to adverse conditions caused by the war, and in 1923 when the output dropped below that of 1922 owing to a power shortage.

The value of gold produced in Ontario during 1923 was $20,082,586.[16] Of this Porcupine supplied $17,313,115 or 86.2%, and Kirkland Lake $2,647,630 or 13.2%. In other words, these two camps alone supplied 99.4% of the gold produced in Ontario during 1923. These same two camps which lie within the "Area" had provided 96.5% of Ontario's total production to the end of 1923, valued at $128,383,395.

One of Porcupine's mines, the Hollinger, ranks with the greatest mines on the Rand in South Africa, both in amount of gold

produced and in the tonnage treated, while other mines in the "Area" are among the largest of gold producers. The Hollinger to the end of 1923 had produced $71,350,112[17] of gold bullion. Owing to the youthfulness of the operating mines, the increased tonnages being treated, the enlargement of the ore reserves, the opening up of new properties and the extensive areas awaiting development, the gold production of Ontario should increase for years to come.

Silver.—The first discovery of silver in the "Area" is frequently credited to a French-Canadian blacksmith named Fred La Rose, whose business was to sharpen the drills of a railway construction gang, and who is alleged to have thrown a piece of steel at a prowling fox, and on seeking his missile found that it had knocked off a fragrant of reddish copper-like mineral which proved to be niccolite, subsequently found to be associated with native silver. This was at Long Lake during the construction of the Temiskaming and Northern Ontario Railway. The name Long Lake was subsequently changed to Cobalt Lake and the surrounding area became known to fame as the Cobalt Silver Camp.

It is understood, however, that the first discovery of silver was made by James H. McKinley and Ernest Darragh, woodsmen, on 7th August, 1903, but proof of this discovery was not filed with the authorities until the 6th October, whereas La Rose's application was made 29th September.[18]

Old mining men were very skeptical as to the discoveries, regarding them as freaks and actual development was held up for a time. However, from 1904 to 1911 the output of silver increased very rapidly year by year. In 1911 the peak of production was reached, when 31,507,791 fine ounces of silver were obtained, the value of which was $15,953,847.[19] In 1912 the output dropped a little but the value increased to $17,408,935,[19] due to a rise in price. Since 1911 the production has been declining, but the life of the camp has been prolonged by the finding of blind veins and especially by improvements in metallurgy which have enabled low grade ore to be profitably mined. Recently the silver production is again rising due to the finding of large bodies of valuable ore in South Lorrain. This camp was practically abandoned but rich veins were struck in the Keeley and Frontier mines, with the result that during 1923 Keeley shipped 1,655,323 ounces and Frontier 1,300,323 ounces of silver.[20] It is believed that there are good prospects of finding additional ore deposits in this district and different companies are at work near Trout Lake. Work is also proceeding in the Gowganda district containing the Miller, Lake O'Brien and Castle Trethewey mines.

By camps the production to 31st December, 1923, has been as follows:[21]

Area	Ounces
Cobalt	327,301,897
South Lorrain	7,295,580
Gowganda	6,467,296
Casey Township	2,799,740
Montreal River and Maple Mountain, etc.	31,267
Total	343,895,780

An average of 2.1 tons of pure silver has been obtained from the Cobalt mines for every 24 hours since they began to yield. The total production of silver in the "Area" to the end of 1923 aggregates 343,895,780 ounces.

Nickel.—The first deposit of nickel copper was discovered during the building of the Canadian Pacific Railway in 1883. In the following two or three years other discoveries were made and in 1886 serious mining operations commenced on a deposit rich in copper, the presence of nickel in the ore not being detected until 1887.

Table No. 5[22] records mining and smelting operations for the last pre-war year, the year of maximum output, and also for the past three years, showing that production has returned to better than a pre-war basis:

Table No. 5—Nickel Copper Statistics

Schedule	1913	1918	1921	1922	1923
Ore raised—tons	784,697	1,643,040	262,593	259,569	1,187,354
Ore smelted—tons	823,403	1,559,892	393,768	314,120	1,140,160
Bessemen matte produced—tons	47,150	87,184	19,498	17,324	58,084
Nickel content of matte—tons	24,838	45,886	9,128	8,678	31,029
Copper content of matte—tons	12,938	23,843	6,323	5,422	15,769
Matte exported—tons	.....	.....	10,466	19,831	21,450
*Matte refined in Canada—tons	.....	5,334	5,558	10,340	31,765

*Refining in Canada began at Port Colborne in 1918.

The total production of nickel from the mines in the Sudbury district from 1889 to the end of 1923 was approximately 474,096 short tons.[23] In the Sudbury ores nickel and copper are always associated and statistics show that nickel occurs in about twice the quantity that copper does.

About 90% of the world's nickel comes from the vicinity of Sudbury, and there are no known deposits elsewhere which can compare with those of this area, either as regards size or in the cheapness of producing the metal. The Sudbury deposits are so

large that they may be considered sufficient for the wants of this and the succeeding generation.

Outside of the Sudbury area, the only producers of nickel in Ontario are the silver mines of Cobalt. But much of the nickel in these complex ores is lost in refining the silver and other constituents.

During the war the demand for nickel increased enormously. It was used in the form of nickel steel in the manufacture of armour plate, guns, etc. While little of it is now used for war material, the demand for nickel in the arts of peace has become so great that the production of nickel ores in the Sudbury area is now larger than it was in the period immediately preceding the war.

Other Minerals.—In addition to the above-mentioned minerals there are several others found in the "Area" which are worthy of mention.

Iron was mined for some years in the Michipicoten area and large bodies of iron ore are known to exist there and in the Moose Mountain district north of Sudbury. Many signs indicate an early revival of the iron mining industry in Ontario.

Copper has been mined in the "Area" since 1886, and to the end of 1922 approximately 259,890 tons of metal had been produced. This copper was mined in the Sudbury district in association with the nickel ores.

The silver ore in South Lorrain is particularly high in cobalt. This latter mineral in the form of an oxide dominates the world's markets supplying the manufacturers of ceramic ware and other users in Britain, Europe and Japan.

Arsenic is found in the Cobalt ores to as high as 30%, and is much in demand for the making of insecticides.

Platinum, palladium, rhodium, iridium, as well as gold and silver and other metals of the platinum group, are present in the nickel-copper ores in the Sudbury area. These metals are recovered as by-products where either the Mond or the electrolytic process of refining the nickel is employed.

It will be seen from the last few pages that the mineral wealth of the "Area" is enormous.

Relation of Power to the Mining Industry.

The district is situated in what has been termed the "acute fuel area" of the Dominion and embraces no native coal resources. It is, therefore, dependent almost entirely on the abundant supplies of hydraulic and hydro-electric energy which are, fortunately, available.

The major hydraulic developments for mining are located in the gold, silver and nickel areas of Northern Ontario in which plants, to the beginning of 1924, over 107,000 h.p.[24] were installed, with several large additional installations nearing completion.

This power has many uses in the mines. The principal ones are compressing air for drilling; driving motors or engines for hoisting; haulage of ore above and below ground; driving ore crushers and conveyors; pumping for water and for removal of ground water; lighting; heating; ventilating; signalling; operating machine, blacksmith and framing shops and for various electro-metallurgical processes. Briefly, large amounts of power are necessary in every branch of the mining industry from the preliminary drilling to the final refinement of the product. When there is added to this the statement that in the comparatively simple process used in coal mining as much as 10% of the product may be used in developing the necessary operating power, the importance of low-priced power becomes strikingly apparent. This is stressed by the fact that coal mines, where possible, are abandoning fuel power in favour of hydro-electricity.

Utilization of Water-Power in the Gold Mining Industry.

Both the Porcupine and Kirkland Lake camps use large amounts of hydro-electric power in operating their gold mines. There are at present four developments, with a total installation of 32,100 horse-power, transmitting electrical energy to the Porcupine field. Three of these, owned by the Northern Canada Power Company, namely, Nos. 223, 234 and 235 on Plate II and in Tables A and No. 3, are on the Mattagami River. The fourth is on the Montreal River above Elk Lake and is owned by the Great Northern Power Co. This development was rushed to completion in 1923 to cope with the power shortage existing at Porcupine, and is shown on the map as No. 173. In the official record of the Hollinger Consolidated Gold Mines it is shown that up to July 13, 1923, there was a loss in production attributable to power shortage of 522,778 tons, averaging $8.15 per ton, representing a grand total value of $4,261,-559.46.[25] So serious had this shortage become that the Hollinger Company announced its intention of developing 24,000 horse-power on the Abitibi River to supply its wants. Shortly afterwards the Northern Canada Power Company announced plans to build a plant on the Quinze River in Quebec, with an ultimate capacity of 60,000 horse-power. With an initial installation of 20,000 h.p. completed on the Quinze River and with the Abitibi development rapidly nearing completion, Porcupine power troubles would seem to be nearly at an end.

Kirkland Lake is served entirely by the Northern Ontario Light and Power Co. This power company has 1,080 h.p. installed in plant No. 162 on the Blanche River and also transmits power from its plants in the Cobalt silver mines.

Larder Lake is supplied by the 1,600 h.p. development No. 164 on the Raven River belonging to the Associated Gold Fields.

Utilization of Water-Power in the Silver Mining Industry.

The demands of the Cobalt silver area are met by plants Nos. 174, 175, 176 and 195 shown on Plate II. These plants are all owned by the Northern Ontario Light and Power Co. The first three are on the Montreal River, while No. 195 is on the Matabitchuan River. No. 175 is a hydro compressed air plant and is equivalent to 5,500 horse-power. The total installation of these four plants is 24,840 horse-power, most of which is used in the Cobalt silver mining industry.

Two small developments, Nos. 117 and 178, on the Montreal River, supply the Gowganda silver mines with power. The former is owned by the South Bay Power Co. and has an installation of 250 h.p.; the latter, with an installation of 800 h.p., is the plant of the Gowganda Power Co.

These plants, with a total installation of approximately 26,000 h.p., are supplying the power wants of the silver mines.

Large blocks of power are necessary in refining the silver ore as is indicated by the fact that silver refineries are located at Thorold and Welland in the area of cheap hydro power.

Utilization of Water-Power in the Nickel Mining Industry.

Water-power is used to a large extent in the nickel mining industry, as in the gold and silver mining industries. Plants Nos. 107 and 108 on Plate II are located on the Wahnapitae River and are owned by the Wahnapitae Power Co., Ltd. The total installation of these two plants is 9,900 h.p. and the output is sold to the town of Sudbury, the bulk of which is resold for nickel and copper mining. Plant No. 57 is a double development at High Falls on the Spanish River owned by the Huronian Co., a subsidiary of the International Nickel Co. Ninety-four per cent. of the output from a total installation of 20,600 h.p. is used by the International Nickel Co. for lighting, mining and smelting. Plant No. 58, owned by the Lorne Power Co., which is a subsidiary to the Mond Nickel Co., Coniston, is located at Nairn Falls on the Spanish River. 4,800 h.p. is installed here, while a further 4,800 h.p. is installed at this Company's plant on the Vermilion River (Plant No. 81). The total output of these two plants is purchased by the Mond Nickel Co. for copper nickel mining and treatment.

Nickel refineries using hydro-electric power are also located at Port Colborne, Ontario, and Des Chenes, Quebec.

It will be seen from the above that there are hydraulic turbine installations aggregating approximately 103,000 horse-power, supplying the power needs of the mining industry in the "Area" as outlined. To this figure should be added the 20,000 h.p. installation just completed on the Quinze River for the Northern Canada Power

Co. and the 25,000 h.p. development of the Hollinger Consolidated Gold Mines, nearing completion on the Abitibi River. These two sites are numbered 138 and 257 respectively on Plate II and Tables A and No. 3. The addition of these two plants raises the total to approximately 150,000 h.p. serving the mining industry of the "Area."

Conclusions.

Hydro-electric power in Northern Ontario has done much for the mining industry. In many cases large scale operations, which alone make the difference between profit and loss, are only made possible by abundant supplies of low-priced hydraulic power. Many mines, on account of their geographical location, would find the cost of rail haul of fuel or untreated ore prohibitive, but with hydraulic power profitable operation has been possible and much low grade material has been given commercial value.

IX. Relationship of Water-Power Resources of the "Area" to the Pulp and Paper Industry

The following basic facts[26] give some idea of the importance of the pulp and paper industry to Canada. 1. At January 1, 1923, the capital invested in the pulp and paper industry in the Dominion amounted to over $380,000,000, a figure only exceeded by our investment in steam railways and central electric stations. 2. The exports of the products of the industry during 1922 were valued at approximately $123,000,000, and were of greater value than those of any other group except that of vegetable products. 3. The industry maintained a staff of 25,830 persons (exclusive altogether of the men employed in the woods) whose salaries and wages for the year 1922 amounted to $32,918,955. 4. The net value of the products for 1922 totalled $155,785,388.

The Pulp and Paper Resources of the "Area."

The pulp and paper resources of the "Area" are found in its immense forests. Several species of trees suitable to the industry are found in this district. Spruce is the main pulping species. Its superiority lies in its strong, tough, colourless fibre. Balsam, poplar and jack pine, as well as hemlock are found in the district. Jack pine has been used for pulping only to a small degree, although large quantities are available.

The pulp industry in Ontario uses spruce to the extent of over 90%, and balsam about 5%.[27] The balance is made up of small quantities of poplar, hemlock and jack pine.

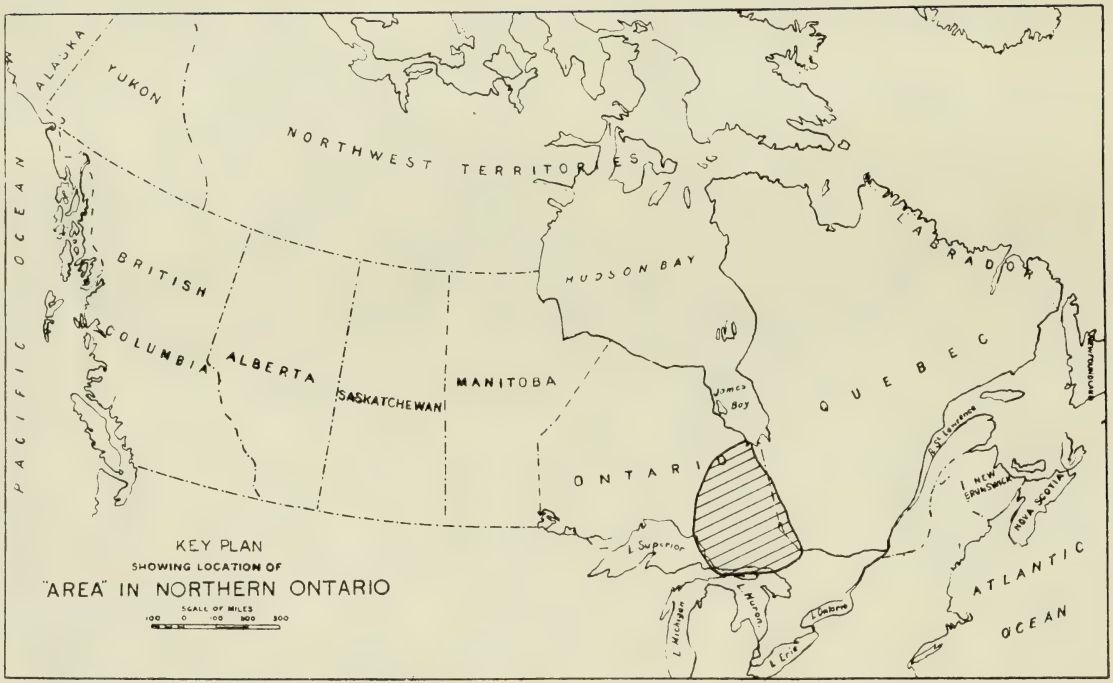

PACIFIC OCEAN
ALASKA
YUKON
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
HUDSON BAY
LABRADOR
QUEBEC
ONTARIO
James Bay
St. Lawrence
NEW BRUNSWICK
NOVA SCOTIA
L. Superior
L. Michigan
L. Huron
L. Erie
L. Ontario
ATLANTIC OCEAN
KEY PLAN
SHOWING LOCATION OF
"AREA" IN NORTHERN ONTARIO
SCALE OF MILES
100 0 100 200 300

PLATE I

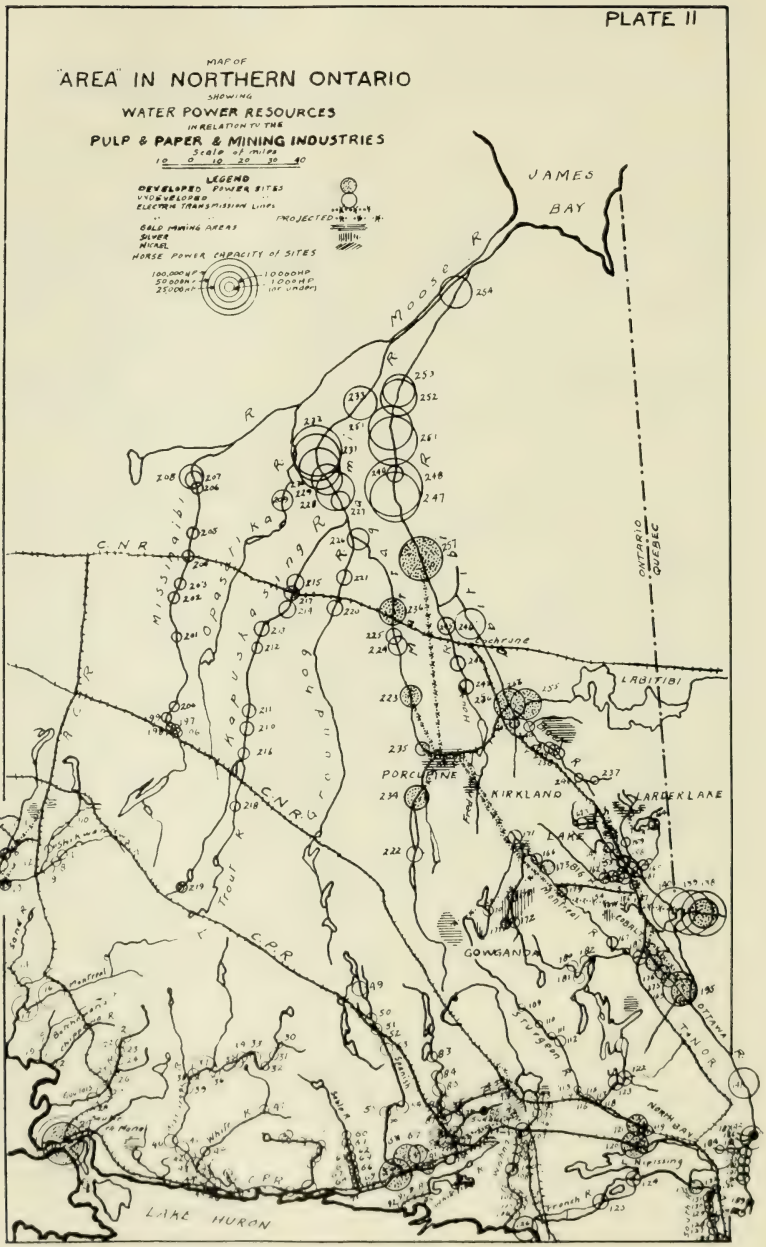


PLATE II
MAP OF
"AREA" IN NORTHERN ONTARIO
SHOWING
WATER POWER RESOURCES
IN RELATION TO THE
PULP & PAPER & MINING INDUSTRIES
Scale of miles
10 0 10 20 30 40
LEGEND
DEVELOPED POWER SITES
UNDEVELOPED
ELECTRIC TRANSMISSION LINES
PROJECTED
GOLD MINING AREAS
SILVER
NICKEL
HORSE POWER CAPACITY OF SITES
100,000 H.P. 10000HP
50,000 H.P. 1000 H.P.
25000 H.P. (OR UNDER)
JAMES BAY
MOOSE R.
ONTARIO QUEBEC
C.N.R.
C.P.R.
LABITIBI
PORCUPINE
KIRKLAND LAKE
LARDER LAKE
GOWGANDA
LAKE HURON
MISSINAIBI R.
OPASATIKA R.
MATTAGAMI R.
MISSISSAGA R.
FRENCH R.
SPANISH R.
WHITE R.
MONTREAL R.
SERPENT R.
MATTAWA R.
OTTAWA R.
NORTH BAY
SUDBURY
CHARLTON
Fraserdale
Cochrane
Kirkland Lake
Gowganda
Sudbury
North Bay
Mattawa
Ottawa R.
Montreal R.
Spanish R.
White R.
Serpent R.
Trench R.
Missinaibi R.
Opasatika R.
Mattagami R.
Mississaga R.
French R.
Moose R.
C.N.R.
C.P.R.
Trout L.
Long L.
Lake Huron

Relation of Power to the Pulp and Paper Industry.

In the production of pulp and paper an adequate supply of power is almost equal in importance to that of raw materials.

In Canada the bulk of the paper produced is newsprint, which consists of approximately 80% mechanical pulp or groundwood, which gives to the sheet its characteristic, to quickly absorb the ink when run through a modern high speed printing press, and 20% chemical or sulphite pulp, which is necessary for the requisite strength.

The production of mechanical pulp requires about 75 h.p. per ton per day, while that of chemical pulp requires about 22 h.p. The actual conversion or paper-making process adds from 15 to 25 h.p., so that for the manufacture of one ton per day of newsprint from 90 to 100 horse-power are required.[28] One large and representative Canadian mill uses on the average 73 h.p. for each ton of mechanical pulp produced, 67 h.p. of which is for the actual grinding alone. The production of sulphite pulp for mixing with groundwood pulp requires 8.7 h.p. per ton of daily output (in certain large mills as high as 30 h.p. is used per ton of sulphite pulp produced), while the conversion of the pulp to newsprint requires 12 h.p. for the same unit of output.[29]

Utilization of Water-Power in the Pulp and Paper Industry.

In any industry the relative necessity of obtaining cheap and adequate power may be gauged by the amount required per dollar value of produce and, with the possible exception of certain electrochemical and metallurgical processes, the requirements for the manufacture of pulp and paper rank among the highest.

It is, therefore, not surprising that over 90% of the motive power in this industry in Canada is derived from the energy of the abundant and advantageously located water falls.

The main item in the cost per unit of power is in the interest on the capital expended in the hydraulic development. Since this is the same whether the plant operates 10 hours or 24, the continuous operation of mills in this industry, usually 24 hours per day, lends itself to the securing of a very low cost per unit of power. This unit cost has been further reduced in the development of the electric steam generator by which any surplus or off-peak power which may be available can be utilized for producing steam for pulp cooking, drying, heating, etc.

In dealing with the water-power utilized by this industry in the "Area" the different centres of pulp and paper production are dealt with separately.

Kapuskasing.—The Spruce Falls Co., Ltd., operate a pulp mill in the town of Kapuskasing. For the purpose of supplying its mill

with power, the Company also owns and operates a power plant at Spruce Falls, some 3 miles distant. The total installation at this plant is 2,500 h.p., part of which is sold to the town for lighting. The Company owns timber limits on this and the Opasatika Rivers. The daily production of the mill is rated at 120 tons of sulphite pulp.

Mattagami.—The Mattagami Pulp and Paper Co., Ltd., has operated a pulp mill at Smooth Rock Falls on the Mattagami River since 1916. The daily output of the mill is 150 tons of sulphite pulp. The Company supplies its own power by means of a turbine installation of 9,350 h.p., 9,000 h.p. of which is direct connected to generators.

The holdings[30] of the Company consist of: 1. Water rights.—The Company holds under lease from the Province of Ontario for 20 years with two 16-year renewals, two water-powers, one at Smooth Rock Falls on Mattagami River developed, and one at Yellow Falls on the same river, undeveloped. 2. Pulpwood limits.—The Company owns in fee simple 125 square miles of timber limits, and controls by lease from the Government of Ontario 840 square miles of Crown timber lands for 20 years with two 16-year renewal periods, estimated to contain 4,000,000 cords of spruce wood.

Abitibi.—The Abitibi area is being exploited by the Abitibi Power and Paper Co. This company operates large pulp and paper mills at Iroquois Falls, Ontario, and has a daily output as follows: Groundwood, 510 tons; sulphite pulp, 140 tons; newsprint, 500 tons; wrapping paper, 30 tons. To operate its mills it owns two water-power plants on the Abitibi River. One of these with a total capacity of 28,000 h.p., is located at Iroquois Falls, while the other, with an installation of 24,000 h.p., is at Twin Falls, 4¼ miles distant. Ninety-five point five per cent. of the power generated by this total turbine installation of 52,000 h.p. is used for pulp and paper manufacturing. The remaining 4.5 per cent. is sold for lighting.

The holdings[31] of the company consist of: 1. Water rights.—The company controls under lease dated September 17, 1912, for a period of twenty years, subject to two renewal periods of 16 years each, from the Government of Ontario, the two water-powers mentioned above. 2. Pulpwood limits.—The company controls under lease from the Government of Ontario, 1,560 square miles of pulpwood lands, estimated to contain over 5,000,000 cords of pulpwood. These lands are situated around Upper and Lower Abitibi Lakes and along the Abitibi River and its tributaries.

The company was incorporated under the laws of the Dominion of Canada on February 9th, 1914.

Spanish River.—There are two pulp and paper mills operating in this district: one at Sturgeon Falls on the Sturgeon River, the other at Espanola on the Spanish River. Both of these mills are owned by the Spanish River Pulp and Paper Mills, Limited, with head office at Sault Ste. Marie, Ontario.

Hydro power plants Nos. 120 and 121 on Plate II, the former with a total turbine installation of 13,390 h.p., and the latter with 5,200 h.p. installed, supply the power needs of the mill at Sturgeon Falls. The Espanola mill is supplied from plant No. 59 at Espanola, where there is a turbine installation of 15,820 h.p.

The holdings[32] of the company consist of: 1. Water rights.—The company develops its own water-power at Espanola and Sturgeon Falls. 2. Pulpwood limits.—Concessions from the Ontario Government are for 21 years from 1910 and comprise about 14,700 square miles, and have exclusive cutting rights from the Algoma Central and Hudson Bay Railway on 2,500 square miles. These limits are estimated to contain 12,000,000 cords of pulpwood.

This company, which was incorporated in 1900, also operates a pulp and paper mill at Sault Ste. Marie, Ontario.

Sault Ste. Marie, Ontario.—The only pulp and paper mill operating in this section of the "Area" is that of the Spanish River Pulp and Paper Mills, Limited, at Sault Ste. Marie, Ontario. This mill is supplied with pulpwood from the company's extensive forest area along the north-east shore of Lake Superior. The company has a turbine installation of 14,400 h.p. and buys its water from the Great Lakes Power Co. The pulpwood limits of the company are given in Section IX, page 42, under *"Spanish River."*

In January, 1924, the total output of this company's three mills was given as: Newsprint, 700 tons daily; groundwood pulp, 650 tons; sulphite pulp, 290 tons; woodpulp board, 35 tons.[33]

From the foregoing sections it will be seen that there is an intimate connection between forests and water-powers, and the pulp and paper industry of Canada is deeply interested in both. The forests may be likened to the back-bone and frame of the industry, while the water-power constitutes the muscles and man-power the brains. The wood is required by the mill for raw material, the river is required in most cases to furnish cheap transportation of the wood to the mill and when harnessed to turbines and generators, to furnish power and light.

Conclusions.

The development and increased production in the manufacture of paper calls attention to the question of the conservation of the wood supply. Each year tremendous quantities of wood are being

cut while fire destroys even more. Unless adequate conservation measures are taken, the pulp and paper industry will soon cease to expand owing to the lack of raw material.

The pulp and paper industry has done much toward the opening up of Northern Ontario. This has been largely due to the availability of plenty of cheap hydro power, since the cost of steam-power in this coalless area would be prohibitive.

The future trend of the industry will be northward with the depletion of more southern forest areas.

X. Concluding Comment

The mineral and forest resources of the "Area" have probably done more towards opening up Northern Ontario than any other agency, unless in this connection there might be mentioned the railways, many of which in turn have been the result of the development of these natural resources. In practically every case the exploitation of these natural resources has been coupled with and dependent upon the development of the readily available hydro power, until at the present day there is installed in the "Area" turbines totalling 296,821 h.p. It would be difficult to find a more striking illustration of the enormous asset which Canada possesses in her abundant supply of low priced hydro energy than that instanced in the relationship of water-power to the exploitation and utilization of the other resources in the "Area" embraced in the scope of this report.

LIST OF REFERENCES

[1] See page 14, Water Resources Paper No. 33, Central Electric Stations in Canada, by J. T. Johnston, C.E.

[3] The power figures used here were secured from data of the Dominion Water Power Branch.

[4] Page 1, Bulletin No. 722, issued by the Dominion Water Power Branch.

[5] Table No. 2 supplied by the Dominion Water Power Branch.

[6] Table No. 3 compiled from data supplied by the Dominion Water Power Branch.

[7] Report of A. R. Webster, Inspector of Mines for Ontario.

[8] Page 183, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[9] Page 283, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[10] Page 182, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[11] Page 15, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[12] Page 1, Bulletin No. 722, issued by the Dominion Water Power Branch.

[13] Page 7 of "Mines and Mineral Resources", issued by the Ontario Department of Mines.

[14] Dates and information from Page 12, of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Department of Mines.

[15] Page 13 of above-named booklet.

[16] Page 14 of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Department of Mines.

[17] Page 9 of above-named booklet.

[18] Pages 30 and 31 of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Deparmtent of Mines.

[19] Page 31 of above-named booklet.

[20] Page 37 of above-named booklet.

[21] Page 40 of above-named booklet.

[22] Page 48 of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Department of Mines.

[23] Page 41 of above-named booklet.

[24] Page 4 of Bulletin No. 733 issued by the Dominion Water-Power Branch.

[25] "Montreal Star," September 29, 1923, by Alexander Gray.

[26] Page 1 of Bulletin No. 731, issued by the Dominion Water-Power Branch.

[27] Page 26, of booklet entitled "Lands and Forests of Ontario," issued by the Ontario Department of Lands and Forests.

[28] Page 473, "The Engineering Journal," July, 1924, by R. W. Leeper.

[29] Page 1, Bulletin No. 731, issued by the Dominion Water-Power Branch.

[30] Data secured from the Dominion Water-Power Branch.

[31] Data secured from the Dominion Water-Power Branch.

[32] Data secured from the Dominion Water-Power Branch.

[33] Page 138, Pulp and Paper Magazine, January, 1924.

ENGINEERING SOCIETY STORE

The
Year Book
of the
University of Toronto
Engineering Society
Faculty of Applied Science
1925

DANCE COMMITTEE

R. A. Fisher R. B. Rochester R. E. Taylor

T. W. Jackson, J. F. Millican (Pres. Eng. Soc.), W. I. Turner (Chairman), V. DeStrickland

The Engineering Society Annual Dinner

It seems to be a terrific task these days to make a Schoolman understand that when he attends a School dinner his invested capital equals value received.

The School Dinner performs the great function of getting the whole School and Faculty together at the festive board and making merry. Its intangible value is priceless and it leaves memories that are indelible throughout the years after graduation.

The 35th Annual Dinner was held at Hart House, Wednesday, November 21st. The menu put forth by Hart House has never been excelled, including everything from soup to nuts. Between courses the School quartet and various entertainment kept everybody in a happy frame of mind, and we all had a very contented feeling by the time Frank Millican gave the toast to the King.

Dean DeLury, Prof. Bain, Prof. Loudon and representatives from McGill, Queen's and R.M.C. responded to the toasts to the University, the Faculty, the Profession, and the Sister Societies, which were given by George Crossgrove, Doug Turnbull, Ro Smythe and Monty Laughlin.

Prof. Haultain then introduced the speaker of the evening, the Hon. Mr. McCrea, Minister of Mines, who gave a most interesting talk on mining in Northern Ontario. This was illustrated by moving pictures which showed the vastness of the mining enterprise in our Province.

The dinner broke up at 11.30, and was pronounced by a professor who had been to at least the last twenty dinners, to be the best he had ever attended. It is hoped that the undergraduates will support the dinner better next year.

Many thanks must be given for the help and co-operation given by the committee, whose efforts made the dinner the wonderful success it was.

W. I. Turner.

The Engineering Society Annual At Home

Science has always had the reputation of holding the best University dances and this year's At-Home held in the Crystal Ballroom of the King Edward Hotel, Friday, February 13th, lived up to all expectations.

At 9 o'clock the guests were received by the patronesses and then amidst ideal surroundings were swung into a whirl of gaiety which, aided by Jardine's orchestra, a superb supper served in the Pompeian

DINNER COMMITTEE

V. B. Lillie C. A. Pollock L. A. Richardosn

V. DeStrickland, J. F. Millican (Pres. Eng. Soc.), W. I. Turner (Chairman), G. M. Crossgrove

Absent—A. D. Morton, J. W. Paerson

Room, and a well-balanced programme, made everybody so happy and hilarious that the dance had to be prolonged till 3 o'clock.

Due to the splendid co-operation of the committee all arrangements were carried out perfectly, and even the other faculties present pronounced the dance to be the best University dance of the year.

W. I. TURNER.

School Night at Hart House

The third annual School Night was held at Hart House on January 30th. The way in which the staff, graduates and undergraduates turned out did much to make the evening a success, and reflects great credit on the School men and this function, which is rapidly becoming a School tradition.

Owing to the decreased registration in School the Engineering Society felt that it could not bear the drain of financing the function. By levying a charge of seventy cents per couple it was made to pay its own way. This charge included refreshments, as well as admission and in this way no loss was sustained through some of those present not buying supper.

The stupendous production in the theatre was extremely well received. By way of a change its theme was a deep dyed mystery, with cold crime, tempered by a hot love.

The outstanding figures in the play were: "Art" Toye as our hero Square Jerry, "Doug" Turnbull as the villainous Sleek Greek, and "Russ" Monnel and "Spike" Sullivan as Sherlock Holmes and Watson respectively.

Much credit is due "Spike" Thompson and his crew on the lights.

This atrocity was written, produced, directed and staged by Ralph S. Kerr, author of Insomnia, who also played the leading feminine role.

Several popular and capable artists were obtained for the programme in the Music Room, who, along with the Hawaiian group of the S.I.C., provided a very interesting and enjoyable entertainment.

The executives of the clubs and three upper years filled the common rooms and corridors with side shows, slight-of-hand artists, wandering musicians, and what-nots. The crowd literally thronged every nook and crannie, and as they seethed and eddied about the points of interest the inner man was forgotten. Lolly-pops, chocolate bars and horns were rained gratuitously upon the mob and helped to create an atmosphere of jollification.

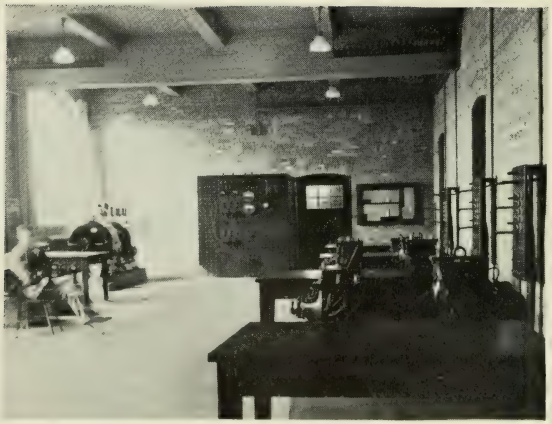
The Tank was reserved for a laughing and swearing room, where the crowd rested as they watched the aquatic endeavours before again breasting the tide.

The Chemicals provided punch and Eskimo pies in a secluded alcove for a nominal fee.

Dancing commenced in the Big Gym and Great Hall at ten o'clock and the crowd drove their dogs around till the witching hour, one o'clock. A good time was had by all.

One hundred and fifteen School men shared the responsibility and work of the evening, and the Committee welcomes this opportunity to express its appreciation of their very able assistance and the co-operation of the staff of Hart House.

J. F. Tanton
R. S. Kerr



Engineering Society Election Results

President ..... Doug W. Dow
1st Vice-President ..... Don C. Beam
2nd Vice-President ..... W. H. M. Laughlin
Treasurer ..... T. B. Smith
Secretary .....A. A. Somerville
Curator ..... W. A. Duncan

Chairmen of Clubs

Civil Club ..... W. H. Kribs
M. & M. ..... A. D. Dickson
M. & E. ..... C. E. Nugent
Architectural ..... H. M. McLaughlin
Chemical ..... J. D. Hawken
Debating ..... E. G. Davies

Athletic Association

President ..... C. A. Morrison
Vice-President ..... J. H. P. Russell
Secretary-Treasurer ..... H. P. Ruggle

Year Executives

Fourth Year—

President ..... E. R. Complin
Vice-President ..... C. H. McGuire
Secretary-Treasurer ..... C. W. Witherell
Athletic Representative ..... G. R. Rumble

Third Year—

President ..... R. B. Rochester
Vice-President ..... J. K. Gardner
Secretary-Treasurer ..... C. A. Parkinson
Athletic Representative ..... G. L. B. Roberts

Second Year—

President ..... J. M. C. Lazier
Vice-President ..... A. B. Hunt
Secretary-Treasurer ..... S. W. S. Hall
Athletic Representative ..... A. M. Grant

S.A.C. Executive

President ..... J. B. Beck
Vice-President ..... R. P. Quance
Secretary-Treasurer ..... D. S. Laidlaw

2T5 Permanent Executive

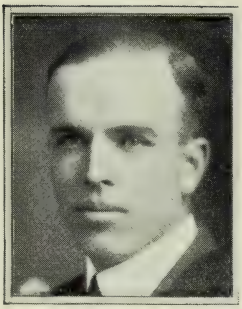
President ..... J. F. Tanton
Vice-Presidents ..... J. W. Kennedy
J. F. Millican
G. M. Crossgrove
Secretary-Treasurer ..... A. D. Morton

School Representatives on Hart House Committees

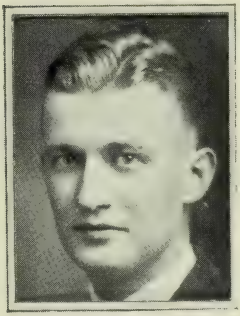
House ..... W. H. M. Laughlin
Hall ..... R. E. Smythe
Library ..... E. G. Davies
Music ..... C. A. Pollack
Billiard ..... P. Wigle
Sketch ..... J. M. C. Lazier

Permanent Executive Classs '25

J. F. TANTON, *Pres.*



J. F. MILLICAN, *Vice-Pres.*



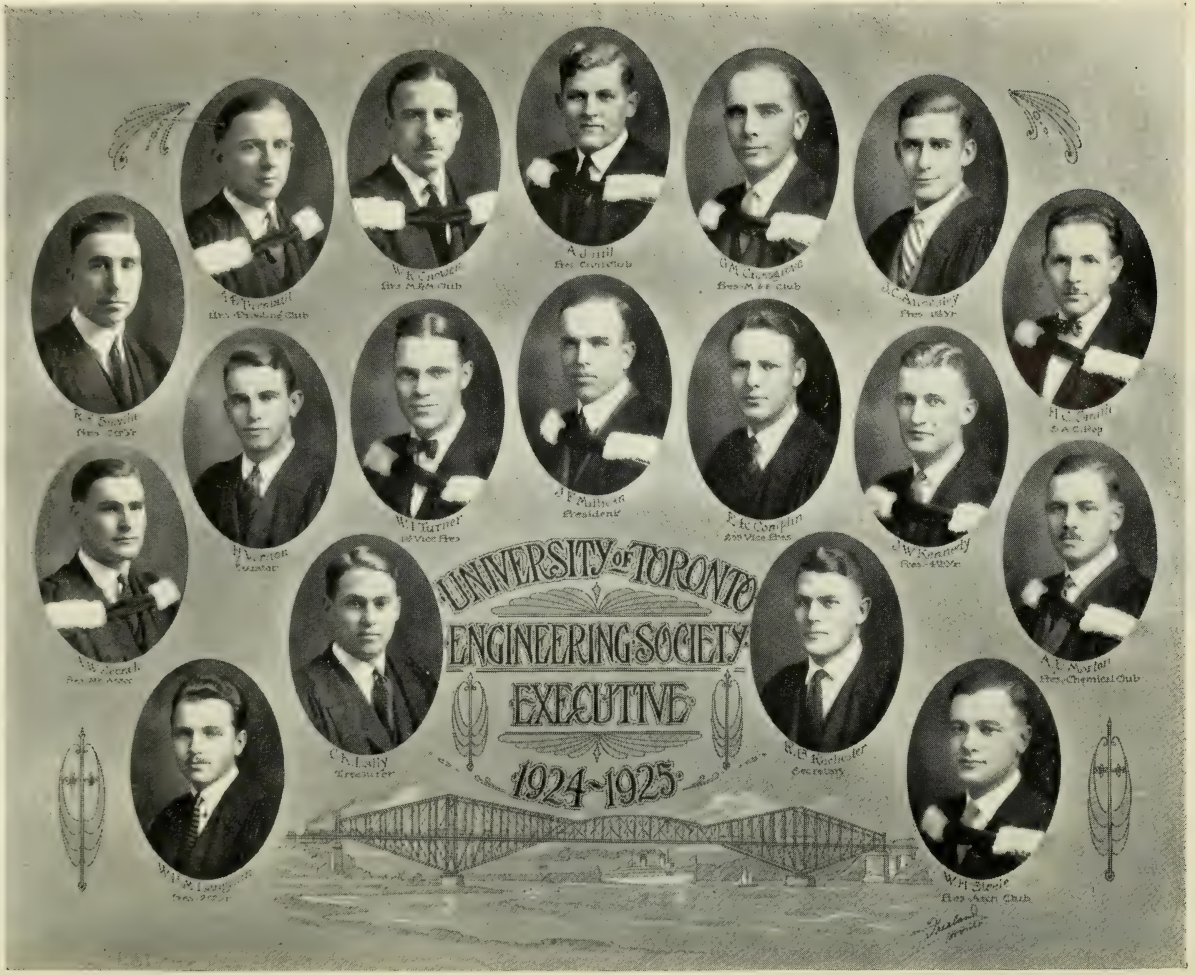
J. W. KENNEDY, *Vice-Pres.*

C. M. CROSSGROVE, *Vice-Pres.*

A. D. MORTON, *Sec.-Treas.*

It is the sincere desire of the Permanent Executive of the Class of 2T5 that the members of this Year make every effort to keep closely in touch with each other. In this way the wonderful class spirit which has been evinced the last four years will stay with us until "death do us part", and will enrich the memories of the time spent in the old Red School House. The secretary hopes that all members of the Year will find time to correspond regularly with him and especially requests that he be notified as soon as possible of permanent addresses and subequent changes.

The Executive take this opportunity of wishing the utmost of health, prosperity and professional success for all members of Science 2T5.


UNIVERSITY OF TORONTO
ENGINEERING SOCIETY
EXECUTIVE
1924-1925
A. J. Hill
Pres. Civil Club
W. K. Chouser
Pres. M&M Club
G. M. Chamberlain
Pres. M.E. Club
J. C. Annesley
Pres. I&D
H. C. Smith
Pres. Chemical Club
A. T. Morton
Pres. Chemical Club
W. H. Steele
Pres. Arch. Club
R. B. Rochester
Secretary
C. R. Lally
Treasurer
J. F. Mathews
President
W. T. Turner
1st Vice Pres.
R. K. Coughlin
2nd Vice Pres.
J. W. Kennedy
Pres. 4th Yr.

The Mechanical and Electrical Club

In reviewing the activities of the Club for the School year 1924-25, the outstanding point seems to be the degree of success which has attended the attempt of the Executive to win back a little of the technical side of the Club's mission. To maintain the high social position attained by our predecessors, and yet enlarge the scope of the Club's activities in this manner, seemed a tremendous step at the outset, but the results have been most gratifying and augur well for the future.

The first shot in this new campaign was fired when the Executive approached both the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, requesting them to run Student Papers' Competitions, open to members of the Club. This they readily consented to do. Both these competitions were carried through to successful conclusions, two prizes being awarded in each case. The Mechanical prizes were awarded to Messrs. F. W. Watson and T. C. Graham, Fourth Year, Dept. 3, and the Electrical prizes to Messrs A. H. Frampton and B. C. Griffith, Fourth Year, Dept. 7. Both Associations held Student Meetings, at which the winning papers were presented by their authors. The success of this enterprise warrants its further trial, and bids fair to make it an annual event.

The second shot took the form of an attempt to organize weekly technical meetings of the Club, at which members would present their own papers. So far, it has not been found feasible to hold general joint meetings, but highly successful meetings of this character have been held from week to week in the separate Mechanical and Electrical Departments of the Fourth Year. These meetings have received the heartiest approval and support of the Faculty, in fact, their co-operation has been wholly responsible for the complete success of this venture. The quality of the papers presented, and of the subsequent discussion, warrants the continuation and expansion of this phase of the Club's activity.

In addition to these meetings, several general meetings of the Club were held, at which addresses were given by prominent engineers. Outstanding among these were return visits of our friends, W. J. Davidson and Kettering, of the General Motors Corp. The reception accorded these men was certainly phenomenal, the large lecture room in the Mining Building being packed at each meeting.

While not exactly a technical meeting the return visit of our friends, the "Hello Girls," must be recorded, as that event also drew a "packed house." The kindness of the Bell Telephone Co. was responsible for the success of this meeting, though some of the boys wondered who was responsible for the "nawsty" knocks they received during the demonstration.

And now to record a little of the social side of the year. The first outing of the Club was the annual trip of inspection to the Niagara power plants. The party, numbering approximately 90, and accompanied by Prof. Angus, to whom the complete success of the trip was due, left Toronto on the early morning boat, arriving in due course at the Queenston Generating Station. To the credit of the Hydro men, who acted so efficiently as guides, nobody was lost during the inspection of the seemingly vast expanse of the plant, and all assembled on the top floor for lunch, which was served by our erstwhile guides. The afternoon was spent at the canal intake at Chippawa, and at the Ontario Power Co.'s intake and plant, below the Falls. After a truly profitable visit the party left Queenston on the evening boat, arriving in Toronto with voices somewhat diminished by much impromptu entertaining on the homeward trip.

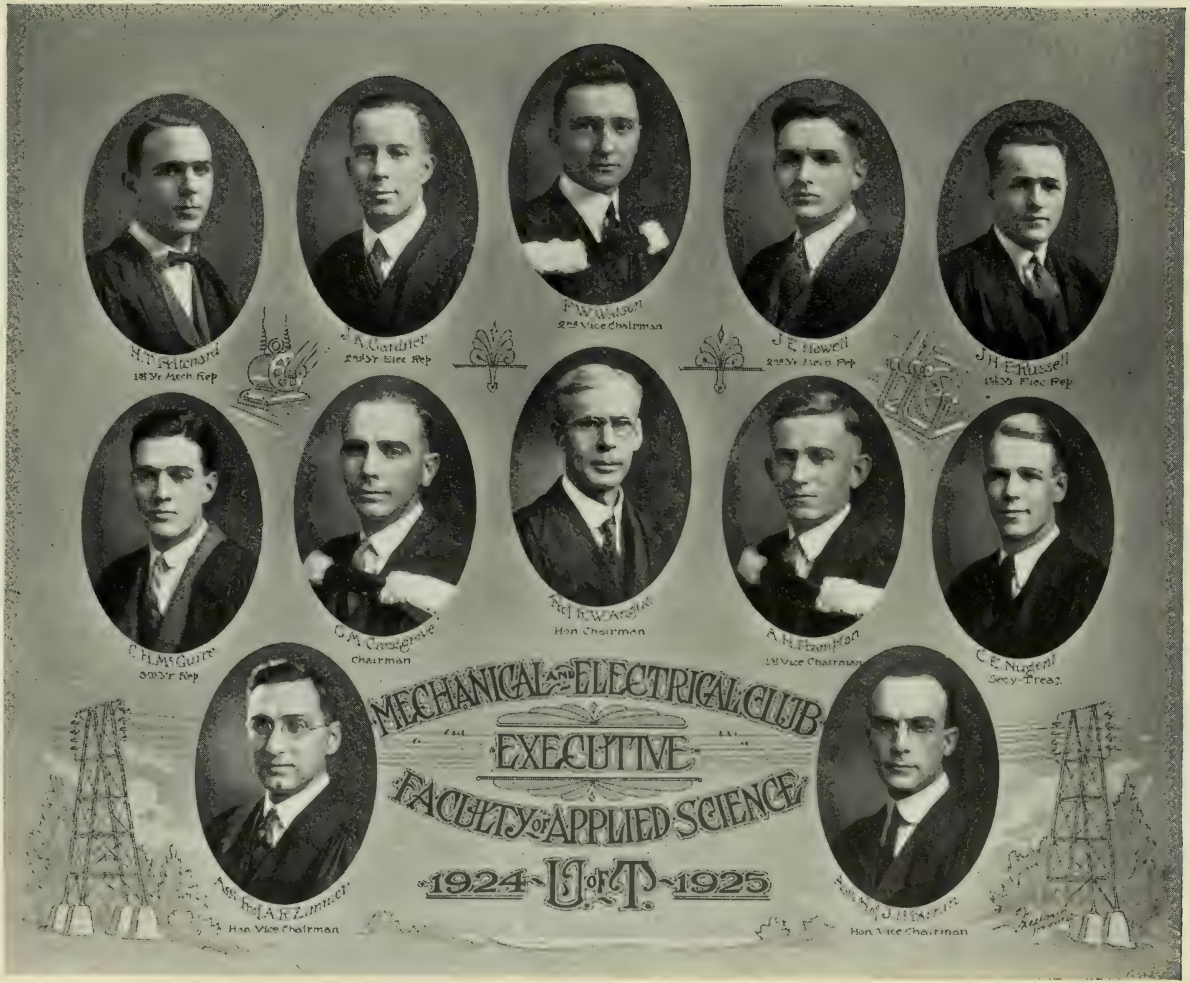
Shortly after this trip we again embarked on the early boat, this time bound for the American metropolis of Buffalo. Special cars were attached to the Lewiston-Buffalo express (?), and all the party—numbering about 160—arrived at our destination O.K. We were cordially received by the Buffalo Board of Trade, who entertained us at lunch, and we spent the afternoon visiting such plants as the Steel Co., Pierce-Arrow Motors, steam plant of the Buffalo G.E. Co., and radio station WGR. Once again the evening boat carried us (and, at least, two packages of American cigarettes) back home.

Two other general trips were arranged, both within the city. The first was to the repair shops of the Transportation Commission at Hillcrest Park, and the other to the Adelaide and Grover Exchanges of the Bell Telephone Co.

It was also the intention of the Executive to carry out the idea of a dinner, as was so successfully done in 1922. However, an unfortunate clashing of dates, after all arrangements had been made, resulted in its indefinite postponement. We must, therefore, leave this idea with the incoming Executive.

This somewhat disconnected account of the year's activities would not be complete without mention of the splendid spirit of co-operation between the Executive and the members of the Club. The success of these new ventures are sufficient testimony and speak well for the future of what we feel proud to call, the best Club in School. In handing over the reins of office to the incoming Executive, we can only say "Good luck."

George Crossgrove, President.


H. T. Hilliard
1st Yr Mech Rep
J. A. Gardiner
2nd Yr Elec Rep
P. W. Watson
2nd Vice Chairman
J. E. Howell
2nd Yr Mech Rep
J. H. F. Russell
1st Yr Elec Rep
C. H. McGuire
3rd Yr Rep
G. M. Craigmile
Chairman
Prof. R. W. Angus
Hon Chairman
A. N. Hampton
1st Vice Chairman
C. E. Nugent
Secy-Treas.
MECHANICAL AND ELECTRICAL CLUB
EXECUTIVE
FACULTY OF APPLIED SCIENCE
1924 U. of T. 1925
Asst. Prof. A. R. Zimmer
Hon Vice Chairman
Asst. Prof. J. H. Parkin
Hon Vice Chairman

The Mining and Metallurgical Club

We've heard about Mechanicals and Chemicals enough,
The Civils and Electricals they, too, have hung a bluff;
Now, let us hear about the boys who make the going clear,
The good old Metallurgists and the Mining Engineers.

The Miners hit the backwoods trail in weather, foul or fair,
And in the stopes and drifts blast out the good stuff buried there,
They face the dangers underground, without a thought of fear,
I guess you have to hand it to the Mining Engineer!

And what becomes of all the precious rock that they dig up?
The metallurgist transforms it from muck to silver cup.
He makes the rails to carry all your trains from far and near,
The king-pin of the others' crafts, the Metallurgical Engineer.

"Si Derite".

"We are miners seeking riches, . . . !" Propriety forbids the rest of the famous yell, but if you want to hear it, place your ear at the keyhole when the boys are in stag session and your curiosity will be satisfied. Other places might be mentioned too, but our theme cries for utterance, so we must proceed.

The first general meeting of the Club was held in the form of a Smoker in Hart House during the last week of October. This meeting is the most important one from the point of Club business of the year, since at this meeting the election of Vice-President, Secretary-Treasurer, and year Reps. takes place, as well as any other business requiring attention. On this occasion these important details were accomplished in spite of much noise and loud cheers, mainly emanating from one, Spike Sullivan, who, fortunately for the patience of the presiding gentleman, at half time felt a little upset gastronomically and retired with some precipitancy, volubly cursing these vendors of bottled T.N.T. Next came the initiation of our newly admitted members, the Freshmen. The ritual of this procedure cannot be made public, so it must be passed over with an apparent lightness, which is far from depicting its actual importance. Then the evening being well advanced, Mr. "Fat" Dickson, the newly elected Secretary-Treasurer announced the fact that lunch was prepared and waiting, so without

Top Row: R. L. Piper (III Year Metallurgy Representative), F. A. C. Shaw (IV Year Metallurgy Representative), L. M. Browne (IV Year Mining Representative), J. P. Dick (III Year Mining Representative,)T. B. Smith (II Year Representative).
Bottom Row: A. D. Dickson (Secretary-Treasurer), W. R. Chowen (Chairman), J. E. Pearen (Vice-Chairman).

loss of time, but with proper grimness and fortitude the members assailed this the last act on the programme.

Thanks to the efforts of Mr. Ernie Pearen, the Vice-President and Mr. Dickson, in November, it was the privilege of the members to enjoy a very satisfactory dinner and a most interesting speaker, the latter being Mr. Balmer Neilly, the secretary and a director of the McIntyre Gold Mines Ltd. Mr. Neilly being a grad. of School of '07 and with a vast experience in our own northern mining fields gave an address which, though delivered in a most engagingly humorous vein, carried with it a wealth of advice and instruction, which will long remain with each member. It was with sincere delight that the executive noted the support of the members of the Faculty by their presence there that evening.

In January a very interesting informal address was given by Mr. Dorfman, consulting engineer for the Huronian Belt Corp., on some of the problems met with in cyanidation, to the senior members of the Club. This subject proved of great interest and opens up a very definite field for research. Prof. Guess is to be sincerely congratulated on his obtaining so instructive a speaker for the senior members of the Club.

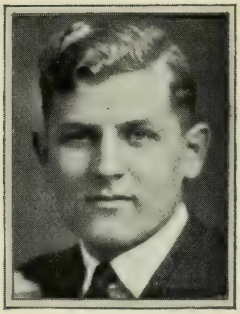
The next meeting of the Club, in form, was an entirely social one. On February 18th, an informal dance was held in the Blue Bird Inn, which passed off most successfully. The Gull Lake Orchestra furnished the music and made some at least of those present recalled, with a little sadness for the joys that have passed, the happy days spent around that spot.

The last meeting of the Club was held in C-32 on Thursday, March 5th. At this meeting, the candidates for the Presidency of the Club for the coming year were given the opportunity of speaking. Candidates for other positions in the Engineering Society seeing this opportunity to present themselves before the members, also spoke, so that the net result was a very interesting and even instructive exhibition of oratory.

The very hearty appreciation of the executive of the Club goes out to Mr. L. M. Browne, Chairman of the Entertainment Committee and his committee for their unstinted efforts in that side of the Club activities. In addition, the executive wish to express their gratitude to those members of the Third and Fourth years who so ably and unselfishly gave of their time and energy to the successful consummation of the Club stunt on School Night.

And now with infinite hope, best wishes and unlimited faith in the future well-being of the Club under the guidance of Mr. "Fat" Dickson, the President for the coming year, we will now "drive" for awhile.

W. R. Chowen.



The Civil Club

The School elections are over; they are a stern reminder that time is drawing nigh. For some of us this is the last time (at least we hope it is).

This year the Club swung into activity on October 30th, with a trip to Oshawa. Here the General Motors Plant was inspected from start to finish. The coming engineers learned something of big scale production, efficiency and plant organization. The party was divided into small groups, each group having a School Grad acting as a guide. This proved very profitable. Before finally leaving the plant each member was presented with a handsome booklet, published by the General Motors people, and called, "Canada as a Builder of Motor Cars".

On January 27th, 1925, the members assembled in Hart House for a very successful smoker. The evening turned out to be a high-class musical gathering. Songs were run off in rapid succession, the music being supplied by a "Gull Lake" orchestra. Messrs. Potter and Teagle did their "stuff", to the amazement of the rest of the members. Professors Gillespie and Young recalled some amusing stories of the late Dean Galbraith. Then Mr. Ben Hokea appeared, and immediately captivated everybody with his playing and singing.

The smoker was finally closed with the customary eats and yells.

The Club was not addressed by any members this year, as it was felt that we get enough technical matter from the Professors.

Nothing but praise can be given to the members on the executive, who have given unsparingly of their time and energy to make the Civil Club a live wire.

The incoming chairman is a man full of ideas, energy and experience, who will do everything to make the Club a success. To Mr. Bert Kribs I pass the bucket.

A. J. Hill, President.

M.R.SCRIVEN
1st YR. REP

PROF GILLESPIE
HON. PRES.

W.L.COOKE
SEC. TREAS.

A.M.TOYE
4th YR REP.

A.J.HILL
PRES.

W.H.KRIBS
VICE. PRES.

CIVIL CLUB EXECUTIVE

1924-25

D.C.BEAM
3rd YR REP.

A.M.WILSON
2nd YR REP.

The Industrial Chemical Club

Chemical Club activities for the year began with a smoker at Hart House. After the First Year members had introduced themselves the election of officers was held and resulted in the following: Hon. Pres., Prof. J. W. Bain; Vice-Pres., J. D. Hawken; Sec.-Treas., W. M. Scarth; Curator, G. L. Andrew; Year Reps., R. S. Kerr, C. W. Witherell, R. E. Richardson, C. F. Burk. Short interesting addresses were given by members of the Club: Messrs. Coppin, Jeffrey and Ryan. The evening was enlivened by a fistic encounter between Terrible Toy and Battling Hubbard.

A week later an expedition sallied forth to inspect industries. The trip included The Lincoln Paper Mill Co. and The Interlake Tissue Mills at Merritton and the Hooker Electro-Chemical Plant at Niagara Falls, New York.

At the November meeting a very interesting illustrated address was delivered by Mr. E. T. Sterne, B.Sc., on the subject of Sodium Silicate. The smoker was preceded by two inter-year baseball games, from which the Fourth and the First Years emerged victorious.

The annual Fall Dinner was held in December at the Prince George Hotel. Professor E. G. R. Ardagh spoke on the subject of Chemical Literature, and Dr. "Bob" Stuart told of his experiences as a medical man in the Canadian Arctic Regions. Prof. Bain supplemented Dr. Stuart's address by some very interesting remarks on early Canadian explorations. Ralph Kerr concluded the evening with a remarkable recitation of the doings of "The Hermit of Shark Tooth Shoals."

At "School Night" the Chemical Club assisted by selling refreshments during the whole evening and incidentally enriched the coffers of the committee to an extent that enabled them to break even on their expenses.

The February meeting was held jointly with the Arts Chemical Club. Moving pictures were shown on "Gold Mining," "Silver Extraction" and "Pulp and Paper." Prof. J. L. Rogers gave a highly interesting and instructive talk on the subject of Toxicology.

The annual nominations produced a three-cornered fight for

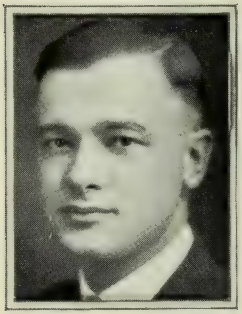
Top Row: C. W. Witherell (III Year Representative), G. L. Andrew (Curator), C. F. Burke (I Year Representative), R. E. Richardson (II Year Representative).

Bottom Row: R. S. Kerr (IV Year Representative), Prof. J. W. Bain (Hon. President), A. D. Morton (President), J. D. Hawken (Vice-President), W. M. Scarth (Secretary-Treasurer).

the position of Chairman of the Club. The election resulted in a tie, making necessary a by-election in which Mr. Hawken eliminated Mr. Jeffrey.

The final "bust" of the year was the annual Banquet held at the Prince George. The time-honoured Dewar Flask was presented, and the members then entered into a heated discussion of various timely topics. After proper thanks were rendered for the support given the Club by its members of the past year the meeting was turned over to Mr. J. D. Hawken, the chairman-elect, with best wishes for future success.

A. D. Morton, Pres.



Architecture

Although the Architectural Club does not loom very large among School activities as a whole, it is nevertheless a very vital part. Owing to its small size, however, and the different nature of its curriculum it may seem a little exclusive.

This year the executive guiding its tender existence consisted of, President, W. H. Steele; Vice-President, J. Ryrie; Secretary, Miss E. M. Lalor; Treasurer, J. D. Mathews; 3rd Year Rep., M. H. Johnson; 2nd Year Rep., R. S. Hanks; and 1st Year Rep., J. M. Mathers.

The first meeting of the Club was a dinner at the Five Sisters' Tea Room. Mr. Molesworth, whom we were very fortunate to have as Honorary President of the Club, in a short address brought home to the members a keen feeling of their relationship with the members of the profession and an appreciation of the work done by the Ontario Association of Architects. Following this was the initiation of the freshmen, which proved very amusing. Each one of them was forced to give an impromtu speech on some trivial subject chosen by their well wishing sophomores.

Later in the year the Club held an afternoon meeting in the School. Mr. A. H. Gregg gave a very interesting talk on office management.

The last meeting of the year took the form of a dinner at the Nora Tea Rooms. Mr. J. P. Hynes spoke on the Ethics of the Profession. A very interesting discussion followed.

Top Row: I. D. Matthew (Treasurer), R. S. Hanks (II Year Representative), M. H. Johnson (III Year Representative), J. M. Mathers (I Year Representative).

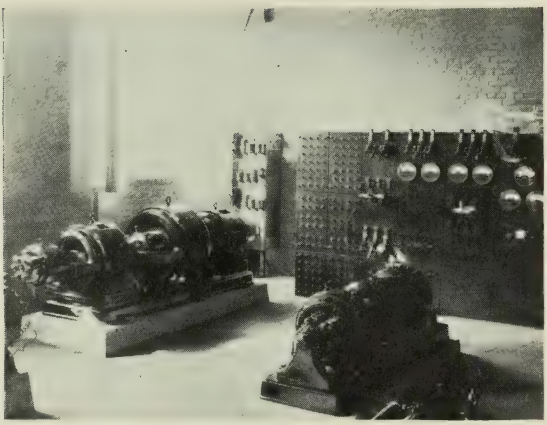
Bottom Row: Jack Ryrie (Vice-President), Harland Steele (President), G. N. Molesworth (Hon. President), H. H. Madill (Graduate Representative), Miss E. M. Lalor (Secretary).

The senior members of the club were fortunate in having a tour of inspection of the Toronto Brick Companies' factories after being entertained at luncheon by the officials of the company. A trip to the McGregor-McIntyre's steel plant was also very profitable. Much credit is due Professor H. H. Madill, who was instrumental in arranging these trips.

On April 4th the Club held its annual exhibition in East Hall of University College. The exhibition was opened by Mr. Vincent Massey. The work of the undergraduates of the course, those taking post-graduate work, and the work of some of the graduates who are now practising, was displayed.

To help stimulate interest in Architecture, by bringing before the public some of the work done by this Department, space has been reserved for a display at the Canadian National Exhibition.

E. M. Lalor, Secretary.



The Debating Club

If a School man would be another Demosthenes he comes out to the meetings of the Debating Club and there, since no real sea is present, orates to the sea of faces. If he has no pebble handy he uses a life-saver.

All authorities, including the present fourth year, agree unanimously that the ability to speak clearly, convincingly, in a manner pleasing to the ear, adequately but not verbosely, is of very great value to anyone who aims to become more than a mere pencil pusher. The ability to think lucidly when on one's feet, and to express those thoughts in suitable language comes only with practice. It is only by practice that a man acquires self confidence and self control, freedom from nervousness and a knowledge of the psychology of audiences.

It has been the function of the Debating Club to provide all comers with this practice. It is probably unnecessary to state that it has been the custom for the club to hold weekly meetings between 5 and 6 p.m. in Hart House. One member introduces some subject in a 5 minute speech, and each man present then gives his views. It is our firm belief that this is the best way to teach the unwilling tongue.

In the Inter-College debating series, Messrs. T. B. Smith and W. G. Raymore of 2nd year debated Dents. The subject was—"Resolved that the increased complexity of modern life due to improved means of transportation and communication is detrimental to the welfare of the human race". School lost after a close debate.

On March 12, the club held its annual Oratorical contest. Three prizes, of value $5, $3, and $2, were given to those taking 1st, 2nd and 3rd respectively. The winner also had his name engraved on the Engineering Society Cup. The contestants gave five minute impromptu speeches on subjects which were drawn at the beginning of the evening. Mr. R. B. Rochester of 2nd year won first, followed closely by Mr. H. Miller, 4th year, and Mr. E. G. Davies, 3rd year, for the honours. The judges were Prof. Haultain, Honorary President of the Club, Prof. Gillespie and Prof. Young.

The officers for the year were:—Hon. President, Prof. H. E. T.

Top Row: V. G. Loscombe (I Year Representative), G. L. Delplante (II Year Representative), H. D. Griffith (III Year Representative).

Bottom Row: N. E. Macpherson (IV Year Representative), A. D. Turnbull (President), Prof. H. E. T. Haultain (Hon. President) J. H. Ings (Vice-President), E. T. W. Bailey (Secretary-Treasurer).

Haultain; President, A. D. Turnbull; Vice-President, J. H. Ings; Secretary-Treasurer, E. T. W. Bailey; 4th Year Rep., N. M. Macpherson; 3rd Year Rep., H. D. Griffith; 2nd Year Rep., G. L. Delaplant; 1st Year Rep., V. G. Loscombe.

Next year the work of the Club will be ably carried on under the direction of Mr. E. G. Davies, and we trust that he will have excellent support.

DOUG. TURNBULL, President.

MEMORIAL TOWER

2T5

We, the class of 2T5 have at last come to the parting of the ways, where each must decide "whether to endure the ills we know or fly to others that we know not of". We are the ones who pass on and in passing leave behind us our contributions to those traditions which will ever bind School and Schoolman.

This, our final year, has eclipsed in every way the record attained in the past three years. Perhaps this has been due partly to a frantic desire on our part to get as much enjoyment as possible before it was too late and partly to a certain feeling of relief that mounts higher as each successive year is safely surmounted and put away as history. Be that as it may, the fact is that everything from the smallest inspection tour to the Grad. Dance has been supported fully and whole heartedly.

Shortly after opening in the Fall, the year smoker was held in Hart House, the entertainment being provided by "local talent", with the added attraction of a few Gull Lake songs.

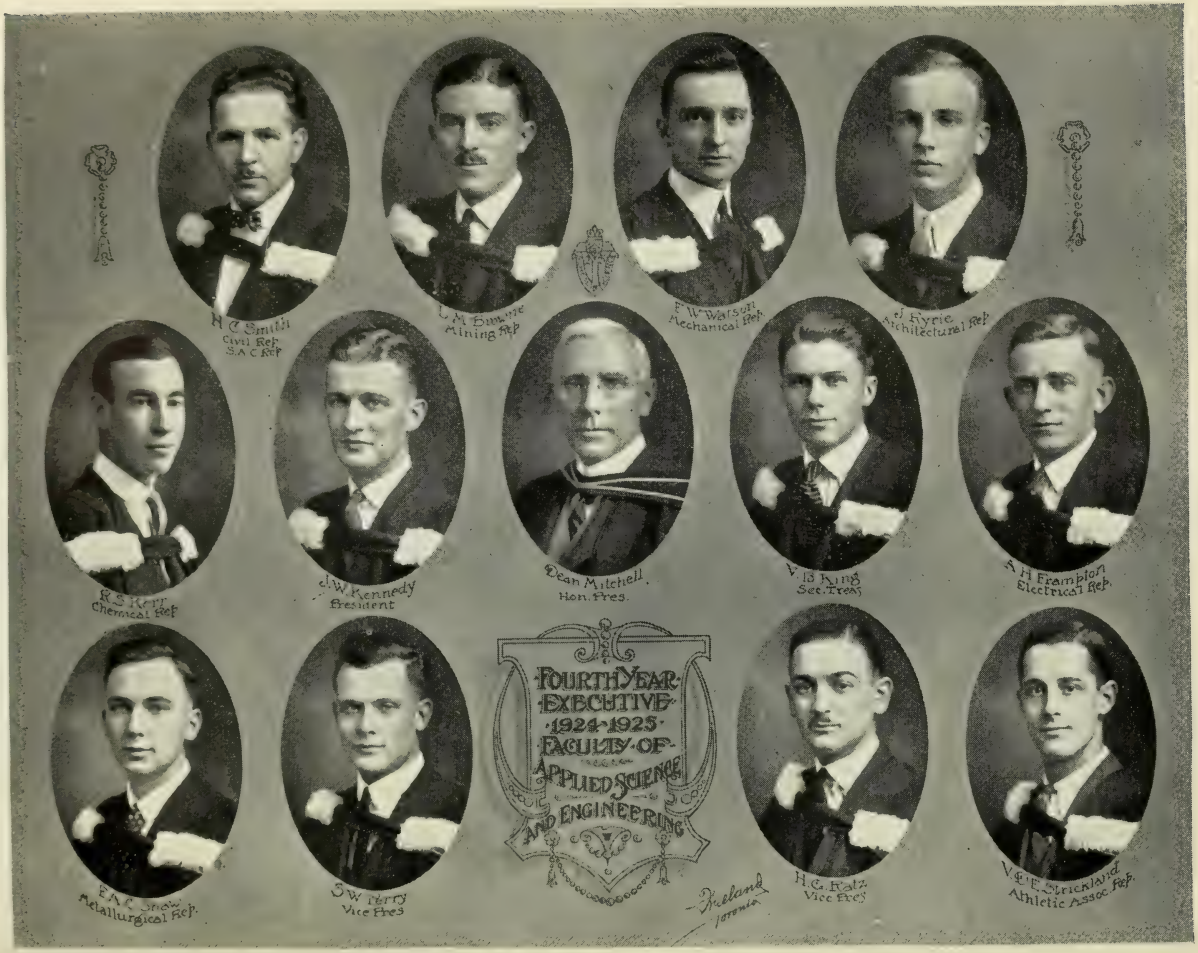
The combining of the 3rd and 4th year informal dances into Senior School Dance was carried out again this year. This function was held at the Palais Royale, November 5th, and was a complete success.

Amongst the reforms and numbers that we call "our own" was a theatre night, (admittedly not a new idea, but at least a revival) which, from the ticket demand, has not lost favour.

Weekly discussion groups were commenced, at which the members of the class provided the chairman, the speaker and the subsequent discussion. This idea, which was started by the M. & E. Club, was really an experiment, but has proved an unqualified success and, it is hoped, will become part of the curriculum.

Undoubtedly our greatest triumph was the Graduation Dance, held in the King Edward on February 27th. The dancers of the year were out in full strength, and reinforced by over twenty of the grads, our farewell dance was triumphantly written into the annals of time.

Each year there is a feeling prevalent that with the passing on of the senior men School's part in activities will be diminished. The old School spirit never fails, however, and we are justly proud of the honours brought to our year by the men who have engaged in the various activities. The indoor baseball, senior basketball and senior hockey teams have been composed mainly by men of the year. Senior School hockey team, under Capt. Bill Strickland, brought the Jenning's Cup back to School, and playing as Varsity Intermediate representatives, lost the Intercollegiate Championship to McGill by one Goal. By Senior School winning the Jenning's Cup and Junior


H C Smith
Civil Rep.
S.A.C Rep.
L.M. Bumside
Mining Rep.
F.W. Watson
Mechanical Rep.
J. Kyrie
Architectural Rep.
R.S. Kerr
Chemical Rep.
J.W. Kennedy
President
Dean Mitchell
Hon. Pres.
V.B. King
Sec. Treas.
A.H. Frampton
Electrical Rep.
FOURTH YEAR
EXECUTIVE
1924-1925
FACULTY OF
APPLIED SCIENCE
AND ENGINEERING
E.A.L. Snow
Metallurgical Rep.
S.W. Perry
Vice Pres.
H.C. Kelz
Vice Pres.
V.E.E. Strickland
Athletic Assoc. Rep.
Ireland
Toronto

School the Mulock Cup, both trophies have come back to School in the same year, for the first time in twenty-one years.

Realizing that we cannot mention all who have been active throughout the year we would like to make a few acknowledgements of help from men not on the executive. To Harry Miller goes the entire credit for the Torontonensis work, which he has handled in a most efficient manner. George Crossgrove has been a staunch worker in the interests of the year, and ever ready with help and advice.

Our future existence as a year has been placed in the hands of the permanent executive, under the capable leadership of Jake Tanton, who will, no doubt, receive the support which has made this year the success it has been.

As we leave School, our feelings are a mingling of anticipation and regret. For four years we have been not only studying engineering—but forming associations that cannot be obtained elsewhere, and which will be ours for life, and we feel that we have acquired an education that enables us to face the future with confidence.

J. W. Kennedy.

Graduating Dance

Friday, February 27th, 1925, will suggest nothing to millions of people in this world, but to the men of '25 that day will always suggest thoughts of a never-to-be-forgotten party. Other days, and other parties, will stand out vividly in a four-year sojourn at School, but that day will always be the day of the Graduation Dance, and as such must go down in history with us.

For this, our greatest party, the Crystal Ballroom of the King Eddie was chosen, with a peppy musical O.C. Such a combination of harmony and harmonious surroundings is hard to beat at any time, but coupled with that mysterious feeling of reckless gaiety which is always associated with the Grad. Dance, the ensemble cannot be adequately described in ordinary language.

No attempt was made to provide decorations in the ballroom, as it is, at all times, outstanding in its crystal simplicity. Over the balcony was installed a creation of T. H. Wells, of our Architects, which depicted a somewhat weary Red Schoolhouse kicking an entirely startled 2T5 out into the arms of a cold, unsympathetic world. The inference was obvious and provided considerable amusement, even among the Patrons, our worthy Profs.

Shortly before supper, a mysterious halt was called. A frantic announcer called for Messrs. Kennedy, Smith, White and Norman. Everybody wondered! The surprise was sprung when Prof. Loudon came forward and made a presentation of a gold watch charm, embodying our year pin, to each one of them, our respective Prexies, as token of appreciation from the year.

Supper was served in the Blue Reception Room, the foyer, and on the balcony. These arrangements worked out even better than was expected, in that the tiring trip up and down the elevators was avoided and the intimate spirit of the party preserved. It was afterwards rumoured that several people lost front teeth providing music (?) on horns and whistles, but we cannot confirm this.

The elimination dance was featured by the distribution of driving harness and whips to each couple. Considerable amusement was caused by the attempts of fair drivers to subdue balky and restive steeds. The lucky reins-miss, Miss Jean Logie, received a 2T5 year pin, and the "prize horse", Mr. Eric Taylor, received the customary red ribbon.

The patronesses were, Mrs. C. H. Mitchell, Mrs. J. W. Bain, Mrs. T. R. Loudon, Mrs. A. E. Allcutt, Mrs. H. E. Haultain, and Mrs. A. R. Zimmer, and the gracious manner in which they entered into the spirit of the evening was a real honour to the year.

The Dance Committee are indeed to be complimented upon the excellence, and completeness, of the arrangements, which made this evening outstanding in our School life, so that all the evenings which are yet to come may be described as "nearly as good as the Grad. Dance!"

2T6

The third year of 2T6 was not uneventful but seems to have contained too many laboratory reports and briefs for the peace of mind and welfare of other endeavours.

As a get-together, a smoker was held in the first term, the class was practically all there, and spirit, School's most precious asset, was with them. The year orchestra excelled under Rex Complin's able guidance, the boxing staged by H. Griffith and L. Grime was most interesting, and the songs of Don Beam and Bert Kribs, both musical and comic. The most interesting part of the evening was no doubt in the flashes of wit and humour, together with the reminiscences spoken by Profs. Bain, Loudon, Young, Cockburn, Crerar, Parkin, and Smithers. More of this would be good for School.

The Senior School Dance and School Night were of the usual high type, and were pleasant diversions, the committees are to be congratulated.

Our year were not all present at the Annual School Dinner; this must be changed, this function must be supported above all others by every School man. It must be considered not only as a School function, but as a professional function.

Concerning elections, much may be written. Some of us have quietly wondered if a better nomination meeting could not be effected, if the meeting were of an orderly nature, and both nominator and nominee given an attentive hearing. Some offices now active may be growing obsolete, and it is at these meetings that candidates can be chosen intelligently.

This last election the year held a nomination luncheon at the Hotel Waverly, after a tasty repast, the provisional nominations were conducted in the following manner. Firstly, nominations received, secondly, withdrawals received, thirdly, nominations received, etc. With a large slate at the head table, changes were made until the very excellent list of candidates were chosen. By having nominations made spontaneously made at a meeting of this kind, it no doubt tends to run the most fitted men for office. Should not the practice of a candidate declaring his intention before nomination be abolished?

The executive wishes to thank the many members of the year who so ably served on committees for dances and "School Night", etc. They wish to express the appreciation of the whole class to those who led the way in athletics, and to Rex Complin and Kip Lally, who so efficiently aided the President in looking after the Society affairs.

We predict a better year next year, and hand over offices to Rex Complin (President elect), Clary McGuire (Vice-President), and C. W. Witherell (Secretary-Treasurer).

R. E. Smythe, President.

2T7

Exam time is with us again and members of the second year are taking things pretty seriously. However, after the year of great activity, both social and athletic, it will not hurt us to settle down and do a little concentrated studying.

With the first part of the Fall term our time was pretty well occupied in coercing the frosh, and by the time of their initiation they had all been reduced to a state of humble submission, due great success, and at this social function the freshmen were given entirely to the untiring efforts of our men. The initiation was a a large dose of real School spirit. No doubt this night will long be remembered by the freshmen as well as by the sophomores. After the initiation a social time was held in Hart House, at which the first and second year men had a chance of getting acquainted under ideal conditions.

The men of our year constituted the backbone of the Junior School rugby team, and at all games were well supported by a large body of second year rooters. In fact, lectures and labs were called off without hesitation, whenever a game was taking place.

Perhaps the largest and most important social function in which our year was closely connected was the Junior School Dance, held at Jenkins, at which over 200 couples, including first and second year and members of other years, were present. Dancing continued until two o'clock and everyone had a good time.

A very successful smoker was held at Hart House in the Fall, at which several members of the Faculty were present and told some very good stories. The year has been very active in athletics along all lines. At the present time we all hope to get over that great obstacle known as "Exams" with the minimum amount of sups and if all goes well we all hope to be together again next Fall.

W. H. M. Laughlin.

2T8

Last October 114 "engineers in the embyro" began their development. After the usual preliminaries, such as "Hats off" and "Ties out, frosh", the initiations took place in the old gym. It may be said that, though we were given a good riding, everything was taken in the right spirit. If there was any hard feeling it must have been removed by the excellent reception given us in Hart House the same night, and we departed feeling that at last we were accepted as brother Schoolmen.

The Annual Soph-Frosh Banquet took place at the Carls-Rite Hotel on December 2. The School Dinner, Junior School Dance, and the School At-Home were also big events of the year, and all received the hearty support of the freshmen. In addition, a very successful smoker was held in Hart House, Ben Hokea being the chief entertainer, while boxing, fencing and a sing-song all went to fill out an enjoyable evening.

In athletics 2T8 was represented on many teams, including Senior Intercollegiate rugby and hockey, Junior Intercollegiate rugby, Senior O.R.F.U., and Junior School rugby, hockey, rowing, baseball and basketball. Great credit is due 2T8 for their exceptionally strong numbers on the above mentioned Junior School teams.

On the track our men won the Inter-year Meet by an ample margin and did considerably more than their bit in bringing victory to School in the Interfaculty Meet.

Freshmen also took an active part in boxing, water polo, jolly old ruggah, rifle shooting, and gymnastics.

The class has very quickly caught the spirit of S.P.S. and the members have mixed well among themselves and the senior years.

If our academic work proves to be as successful as our athletics, then for 2T8 the auguries are good. But, as old Horace would have it—

"Aequam memento rebus in arduis
Servare mentem non secus in bonis
Ab insolenti temperatam
Laetitia. . . . . ."

Or in other words, "Be neither downhearted if things go wrong, nor over confident in success".

J. C. Annesley, President.

School Athletics, 1924-25

The School Athletic Association

As the years pass by it seems that we of School always appropriate a good fair share of the Interfaculty competitions. The past year has proved no exception in that, as we glance over the list, we see that six championships have been annexed, thus leading the Faculties in numbers. The results of the season show:

School—Rugby, Mulock Cup, Junior School; Hockey, Jenning's Cup, Senior School; Track, Outdoor, Lanky Rowell Cup; Indoor, Toronto Cricket Club Cup; Basketball, Sifton Cup; Rowing, no cup.

University College—Swimming, Fitzgerald Cup; Water Polo, Eckardt Cup.

Ontario Agricultural College—Soccer.

Medicine—Boxing, Wrestling and Fencing, Davidson Cup.

The winning of several of these, namely, the Mulock, Jenning's, and Sifton Cups, provided some exceptionally exciting final games, as the reports show..

Rugby during the past year was in favourable shape with Junior School proving the best of the series. We were represented on the Varsity teams in somewhat better numbers than during the past two years. On the Intercollegiate and O.R.F.U. teams we were represented by nine men, on the Intermediates by six men, and on the Juniors, who won the only Intercollegiate Rugby Championship of the year, by nine more. Only six of these are graduating, which should mean that School will soon be back to the days when these teams had a larger percentage than at present.

Hockey proved another bonanza when the Jenning's Cup finally found a resting place. This cup has been away for some time and as the team will be severely broken up by graduation, we hope that the team's successors will be able to retain it. This year Sr. School, as winner of the Jenning's Cup series, represented Varsity in the Intermediate Intercollegiate, and proved worthy contenders, although losing the finals against McGill by one point. All School men are justly proud of such a fine team.

For several years past, the School track team has proved invincible and as long as we have such men as Pollock, Morrison, McKenzie, Russell and others to carry on with, track trophies should find a permanent berth with us for some time yet.

This year no faculty or college can have any doubt but that School possesses the best of Interfaculty basketball material. With Junior and Senior School playing the final game for possession of

Top Row: G. B. Smith (II Year Representative), D. J. McKenzie (I Year Representative), C. A. Pollock (III Year Representative).
Bottom Row: C. A. Morrison (Secretary-Treasurer), A. E. Jeckell (President), Prof. T. R. Loudon (Hon. President), A. A. Somerville (Vice-President), V. D'E. Strickland (IV Year Representative).

the Cup the series has been well decided. Such a coincidence does not occur very often and when it does many of us do not realize the significance of it. The Cup should be well defended next season.

There is hardly any other sport indulged in with as much interest as rowing, the latest arrival to Interfaculty sport. Some credit for this may be attributed to the remarkable showing of the Varsity Senior Crew in the 1924 Olympics, but it is our guess that it is due more to the efforts of an untiring executive. This Association wishes the Rowing Club every success under their new constitution. Schoolmen have an enviable record to uphold in the Fall regatta and with the material on hand this should not be very difficult.

By now School should have learned the danger of not looking to the future at all times, but evidently not, for this happens to be the second year that swimming and water polo have suffered from lack of new men to fill the places of those who have passed on. To counteract this two teams were entered in the water polo schedule this year. Lack of entries in the swimming meet proved a handicap to point getting, so essential to winning a championship. A School swimming meet might remedy this and is certainly worth trying. This is not a lament because we haven't won, but represents the true state of affairs. It is high time we lifted the cups away from U.C. anyway.

After several years of vain struggling for a championship, the soccer club, feeling the strain of decreased registration influencing the calibre of their teams, believe a change would be beneficial. They suggest a first and second team, a plan which has some drawbacks, as a second team invariably suffers. A counter suggestion from the association as to a Junior and Senior play-off before the season, the best players to represent School in the Interfaculty series with one team has been made. This state of affairs has not been confined to soccer alone, as nearly every activity is feeling the same pinch. This will be one of the problems of the new executive next year.

The improvement shown by U.C. in the Senior Assault this year is what School, in the next few years, should strive to attain. At the start of a season we appear to have plenty of material, as evidenced by the School and Junior Assault, but what becomes of these men when the Senior takes place? Are they afraid to face the champions? If they only knew the champions worry more than they. School will be poorly represented next year if there is not a decided improvement. Loscombe in boxing, and Lee in wrestling, will be practically alone. Everyone should know how to fight, whether he has to or not, so why not more enthusiasm?

In indoor baseball the School teams this year were made up of men, most of whom were partaking in other sports. This is never

good policy, but under the circumstances seems inevitable, and explains our losses.

Interfaculty tennis has not yet become what it will in time attain. Efforts are being put forth by the U. of T. Athletic Association to provide suitable courts but until this is done, tennis does not appear to have a proper chance.

It is indeed pleasing to note the variety of athletic talent that 2T8 has produced. Duncan and Trimble of the Intercollegiate rugby team and Kirkpatrick of the Intercollegiate hockey team have already brought three first colours to the year's credit, while others look promising for next year. The championship Mulock Cup and Junior Intercollegiate rugby teams were composed largely of our worthy "Frosh". All in all, 2T8 has a fine record and deserves congratulations.

Of those graduating School is losing one real outstanding Interfaculty sportsman. E. M. (Tiny) Little has set a record for consistency and variety of endeavour worth mentioning. Those who have played with him know his qualities and to those who don't his record, which should be everybody's aim, follows:—

Basketball—1922, Sifton Cup Champions, 1923.
1924, Sifton Cup Champions, 1925.
Water Polo—1923, 1924, 1925.
Indoor Baseball—1922, 1923, 1924, 1925.
Hockey—1924, Jenning's Cup Champions, 1925.
Rugby—Mulock Cup Finalists, 1924.
English Rugby—Intercollegiate Champions, 1923, 1924, 1925.

To pick those most worthy of mention in Interfaculty sport is hard, but among others of 2T5 ranking high might be mentioned:

Cliff Booth for water polo, swimming, rugby.
Frank Millican (T) for track, rugby.
Warren Lloyd (T) for baseball, rugby, rowing.
Paul White for rugby, hockey.
Doug Turnbull (T) for track, harrier.
Ted. Hubbard (T) for boxing.
Bill Turner (T) for track.
Dave Lloyd for boxing, rugby.
Don Melick for soccer.
Spence Perry (T) for track, soccer.
Les Polack for track.
Fred Milne for soccer.

While of those to foster sport, George Smart (T), heads the list without peer.

During the year the executive have deemed it appropriate to grant 'S" to the following men:—

1924-25 "T" Holders

W. S. Kirkpatrick, 2T6, rugby.
N. G. Scott, 2T7, rowing.
R. A. Fisher, 2T6, rowing.
H. Vernon, 2T7, rowing.
F. A. Sievert, 2T7, rowing.

Soccer

F. J. Milne .
J. M. Milne.
J. W. Ryan.
A. H. Frampton.
J. F. Bridge.

Track

F. H. Vercoe.

Jr. School Rugby

Mulock Cup Champions

C. A. Parkinson.
J. A. Carrick.
C. A. McMartin.
W. D. A. Chisholm.
J. W. George.
A. M. Wilson.
R. B. Rochester, and rowing.
J. H. Fraser.

Sr. School Rugby

V. B. King.
G. B. Sullivan.
F. J. Wallis.

Rowing

R. M. Clark.
B. O. Heron.
W. U. Shaw.
A. J. Douglas.

Jr. School Basketball

A. G. Ballachey.
H. S. Irwin.
E. G. Willard.

Hockey

Jenning's Cup Champions

V. D. Strickland.
J. L. Johnson.
V. B. Little.
F. A. Sutton.
J. R. Auld.
A. E. Tuck.

Sr. School Basketball

E. G. Davis.
L. Grime.

General

A. C. Lee, wrestling.
A. J. Hill, swimming and water polo.
R. W. Teagle, indoor baseball.
R. E. Taylor, indoor baseball.
C. W. Dillane, hockey and baseball.

Freshmen 27S

"T" Holders

W. A. Duncan, rugby.
H. J. Kirkpatrick, hockey.
G. F. Trimble, rugby.

Track

C. F. Burke.
D. J. McKenzie.
J. H. Russell.

Rowing

H. Skey.

Boxing

V. Loscombe.

Jr. School Rugby

Mulock Cup Champions

E. J. Calnan.
E. W. Moody.
M. B. Furber.
R. V. Weldon.
S. W. S. Hall.

Jr. School Basketball

C. W. Faber.
J. H. Ryan.
T. C. Swartman.
A. D. McKinney.

The funds of the Association have been expended in the following manner:—

Assets

Fees	$ 488.00	
Mulock Cup gate receipts	89.76	
School Assault receipts	9.57	
Balance (1923-24)	13.50	
Total		600.83

Expenditures

To "S"	$ 100.50	
" Torontonensis pictures	60.00	
" rugby	135.40	
" hockey	70.77	
" track	17.45	
" basketball	53.45	
" indoor baseball	3.50	
" swimming and water polo	18.60	
" rowing	31.00	
" soccer	95.20	
" B. W. & F.	18.13	
Total		604.00

This shows a debit balance. The main reason for this is due to the fact that as the registration, *i.e.*, fees, decrease, the cost of outfitting the teams remains constant. This year the executive has made every effort to be as economical as possible but until the fee is raised it is impossible to outfit all teams in an efficient manner and give suitable memoirs to championship teams and to men breaking interfaculty records. It is hoped, therefore, that the request for an increase in the athletic fee to $2.00 will be cheerfully responded to.

To the new executive the old wishes all success. It is well guided by Charlie Morrison, who has acted on the executive for the three past years. Who could want more?

And last but not least, the executive tender their greatest appreciation to all managers, especially those of rugby, hockey, and basketball, for the help they have freely given.

A. W. Jeckell,
President S.P.S. A.A.

Rugby

SENIOR SCHOOL

The Senior School Mulock Squad started the season well, about twenty-five men turning out to the first few practices. The services of Keith Carruthers were obtained for coach and things looked rosy indeed.

We played our first game against Dents and defeated them by the score 7-0. Then the trouble started!!! The Senior Med. manager defaulted, on behalf of his team, our first game together. The morning of the day that the game was scheduled, Meds. informed us that the game was on. The scrub team that we put on the field was quite badly defeated.

Dents sprung a surprise in their return game, and won for the first time in two years. The game was played in the sandy loams of St. Mike's and our fast light backs were unable to get away, and—well, we lost!

In our last game, the return game with Meds. a good time was had by all. Meds had already won the group, and so "School" had nothing to gain—except frowns from the staff for missing another Lab. The result was that only eleven men showed up; and, well, we played five-minute periods, with the opposing managers refereeing.

Taking it all round it was not a very successful season.

The following men made up the squad: Brown, Connolly, Griffith, Grime, Hewitt, Hunter, King, Jeckell, Leitch, Lloyd, W., Lloyd, D., Little, Nugent, Pentelow, Rumble, Shaw, Switzer, Sullivan, Tribble, Wallis, Warner, McKendrick, Parker.

J. W. Pearson,
Manager

JUNIOR SCHOOL

JUNIOR SCHOOL RUGBY

Once again the Mulock Cup journeys to the Old Red School, after an absence of one year. This past season Junior School was responsible for its return. From the first group game to the final with Trinity the team went through without a defeat. The men rounded out into a well-balanced rugby team under the able tutorage of Capt. Jess Carrick during the group games, and after defeating O.A.C. on a heavy snow-covered field went into the semi-finals against Senior Meds. Two games were necessary to decide the issue, and both were played on muddy fields in drizzling rain.

Top Row—S. H. Fraser, G. B. Smith, M. B. Furber, S. W. Hall, W. M .Scarth (Mgr.), E. A. Cash, G. T. Hughes, W. D. A. Chisholm.
Middle Row– E. S. Calnan, C. A. Parkinson, J. A. Carrick (Capt.), N. Scott, E. W. Moodie.
Bottom Row– C. D. Carruthers, J. W. George, H. T. Pritchard, R. B. Rochester, L. E. Shore, R. V. Weldon.
Insets –T. S. Granton, C. A. McMartin, H. C. Smith, A. M. Wilson.

Each faculty turned out almost *en masse* to support their respective teams, and they were not disappointed, for the quality of rugby played was of the best. Both teams, traditional rivals, were confident and closely matched. The second game was the better of the two and kept the crowd on their feet from the first to the last whistle. Two overtime periods had almost gone when Parkinson kicked a deadline, followed by another inside a minute, giving Junior School the game—score 14-12. This game, although played under such adverse conditions, was the cleanest and most sportsmanlike game played in the Mulock Cup series this fall.

The game with Trinity again brought the whole School to the Stadium to support their team. Odds were against School at the start, for the crowd, considering the two hard games with Senior Meds., thought they would be outplayed, but not so. Trinity opened on the offensive and had a two-point lead at the end of the first period, but School settled down to play rugby and never was the game in danger after the second period.

To pick stars from the team is difficult. A major portion of the credit for Junior School's win must be assigned to Capt. Jess Carrick. He coached the team during practices and took his place with them on the field where he was one of the most effective men in the line. On the back line were "Parkie" Parkinson, "Earnie" Cash and Scott "Y." A large measure of the team's success was due to this trio, for when long gains were required it was only necessary to pass the old pigskin to any one of the three, or when a couple of yards were needed to move the yardsticks Calnan could always be depended on to go through the line for the required gain. Charlie McMartin played a consistent and brainy game at quarter. He brought the team through many of the most crucial moments and always had the right play ready for the right time.

In the line "Gummy" Rochester, "Steamer" Hughes, Furber and Moodie played a steady and effective game. Seldom was a kick blocked or a play broken up through them. "Jim" George played his first game against Junior Arts at middle, but was later transferred to flying wing, which position he played until the first game with Senior Meds., when a sprained ankle forced him out for the rest of the season. His absence from the team was severely felt during the remaining games. Hall came to the team late in the season, but played a most effective game at outside. He and Moodie featured their playing with spectacular flying tackles and invariably brought their men to earth.

Mention of the team without the manager would be incomplete. "Monte" Scarth, by his close personal touch with the men, kept them working like a well-oiled machine, and did much to bring about the spirit of good-fellowship that was present throughout the season.

English Rugby

For the past several years Varsity has had a team to represent her in Intercollegiate English Rugby. Each year a home and home series is played with McGill, and for the past three seasons Varsity has come out victorious.

During this past season the team defeated the Toronto English Rugby team twice and won the right to challenge the Montreal English Rugby team for the McTier Cup. Unfortunately Varsity lost out in the final game, by the small score of 9—6.

Next year Guelph expects to put a team in the Toronto league, which will mean more games for Varsity to play.

It is a source of pride to School, that on this team, as on most Varsity teams, the engineers have a good representation. In fact more than half of the team last year were from School. Included in the line-up were, H. M. S. Pentelow, A. W. Jeckell, G. R. Curry, L. H. Burpee, E. M. Little, A. C. Lee, D. T. Morris, A. R. Battye, Parlser, Russell, and several others.

Most of these men are graduating this year and if School is to be properly represented on the team next year, there will have to be strong support from every man who is interested.

L. H. Burpee.

Hockey

The Interfaculty Hockey Season of 1925 was one of the most remarkable and at the same time one of the best in the history of the series. The best thing about it as far as the Engineers were concerned, was the fact that its close found the Jenning's Cup back in its original home in the Old Red School after an absence of many a long year.

Before the season opened, School was not even considered among the possible contenders, grouped as they were with the strong Med. team, champions of 1924. To the surprise of everyone, however, the end of the regular season found the ancient rivals deadlocked, and the play-off resulted in an overtime victory for School by a score of 3—2. Victoria next provided the opposition, and carried S.P.S. through two extra periods before admitting defeat.

The semi-final was played at the Arena, and on the big ice School exhibited too much speed for the Forestry sextette, earning the decision by a score of 5—0. The final found two of the greatest

teams ever turned out by the Interfaculty Series, pitted against each other. Junior Dents, fast, light, and clever; Senior School, under the tutelage of Fred Evans had developed a fast systematic attack and possessed an advantage in weight. After sixty minutes of first-class hockey, the Engineers skated off, with a well earned victory to their credit. The score was 3—1.

The team was built around three men; Little in goal, Strickland, captain and defence, and White, the leading scorer and most outstanding player in the league at right wing, but the rest were not far behind them in ability. Auld teamed up well with Strickland, and shone most where the going was the heaviest. Sutton and Connolly on the forward line were mainly noted for their backchecking, though their unselfishness on the attack greatly contributed to White's scoring average. Johnson and Little, the subs, could fill in without weakening the team, while Wallis, Tuck, Dillane and Parker, who completed the squad, not only gave the regulars splendid opposition in practice, but acquitted themselves well when given an opportunity in a regular game.

As Interfaculty Champions, School passed on to faster company, representing U. of T. in the Intermediate Intercollegiate, under the name of Varsity 2nd. Connolly and Johnson were ineligible for this series, and were replaced by Lively and Toskey, the two Med. stars. McMaster were the first opponents to be faced, and won the opening game by a score of 4—1. In the second, however, Varsity seconds tied up the round, and won out in overtime by a score of 6—5. The final was played at Kingston against McGill, and notwithstanding their lack of experience, Varsity put up a mighty battle and were only beaten by a score of 2—1. Hewitt of Junior Dents played goal in this game, Little being laid up with a sprained ankle, and it must be said in justice to him and to the two Med. stars that they worked even harder alongside of their late opponents than when pitted against them.

With White, Strickland, Little Johnson, and Lillie graduating, the outlook for next year does not look bright. Auld, Connolly and Sutton, however, remain, and with these as a nucleus School is assured of a team which, imbued with the same fighting spirit that carried this year's squad to a championship, should prove worthy successors to the greatest team that has ever represented S.P.S.

JOHN ROPER, Manager.

Association Football

During the past year football around the University has been steadily rising to its proper place in athletics. In the intercollegiate series, McGill, after an absence of several years, entered and won the honours. The Intercollegiate Union next year promises to be at full strength, with McGill, R.M.C. and Varsity entering teams. It was hoped that Queen's would be back but indications are not very bright.

The Varsity team this year was defeated by R.M.C. on the latter's grounds by the score 4-3 in 20 minutes overtime, and they in turn were defeated by McGill. The Varsity team also made a short tour of the States playing Penn. State and Swarthmore, losing to Penn. State 1-0 and playing a scoreless tie at Swarthmore. Both games were keenly contested, good soccer and good spirit being displayed. School was represented on the Varsity team by D. Melick, but next year School promises a greater representation.

In the interfaculty series the teams were greatly handicapped by lack of grounds for practice purposes, due to the resodding of the back campus. In spite of the lack of practice, the brand of soccer played by the teams was of a high calibre. Junior School's hopes of winning their group were lost due to their inexperience, Victoria winning the group honours. However, the Juniors showed good fighting spirit and are sure to be heard of in the future. Senior School suffered a great deal from lack of practise but displayed good form in the later games. Knox won the group title after several hard fought games.

In the semi-finals O.A.C. defeated Victoria in home and home games but Dents and Knox set a record for the games, six games being played before Dents finally were declared winners. In the final play-off O.A.C. defeated Dents in home and home games and keep the Arts Faculty cup for another year.

Next year School promises to be back again in the race for the cup which O.A.C. has now held for three years. The seniors lose several good players with the graduation of 2T5, but the ones coming up from the junior ranks promise to fill the gaps.

The team this year was coached by Prof. Allcut, who several times came out to coach the team at morning practices. The effect of his coaching was shown to a marked degree in the last few games played.

The following are the players who comprised the teams during the past season:—

2T5—Perry (S), M. Milne (S), F. Milne (S), Ryan (S), Bridge (S), Melick (S), Frampton (S), MacEwen and Dunbar.

2T6—Armour (S), Legge (S), Cade, Yuill and Morrison.

2T7—De Laplante, Roberts, Shields, Burnside, Barnes, Clark, Boles, Grass, Hillier, Hunter and Sievert.

2T8—Magnan and Smith.

(S) denotes players who have been awarded colours for soccer.

T. A. LEGGE, *Manager.*

Track

For another year School has held the Interfaculty Track Championship, making the sixth consecutive year.

The new trophy put up this year was the Langford Rowell Memorial Cup, given by the Victoria College Athletic Association.

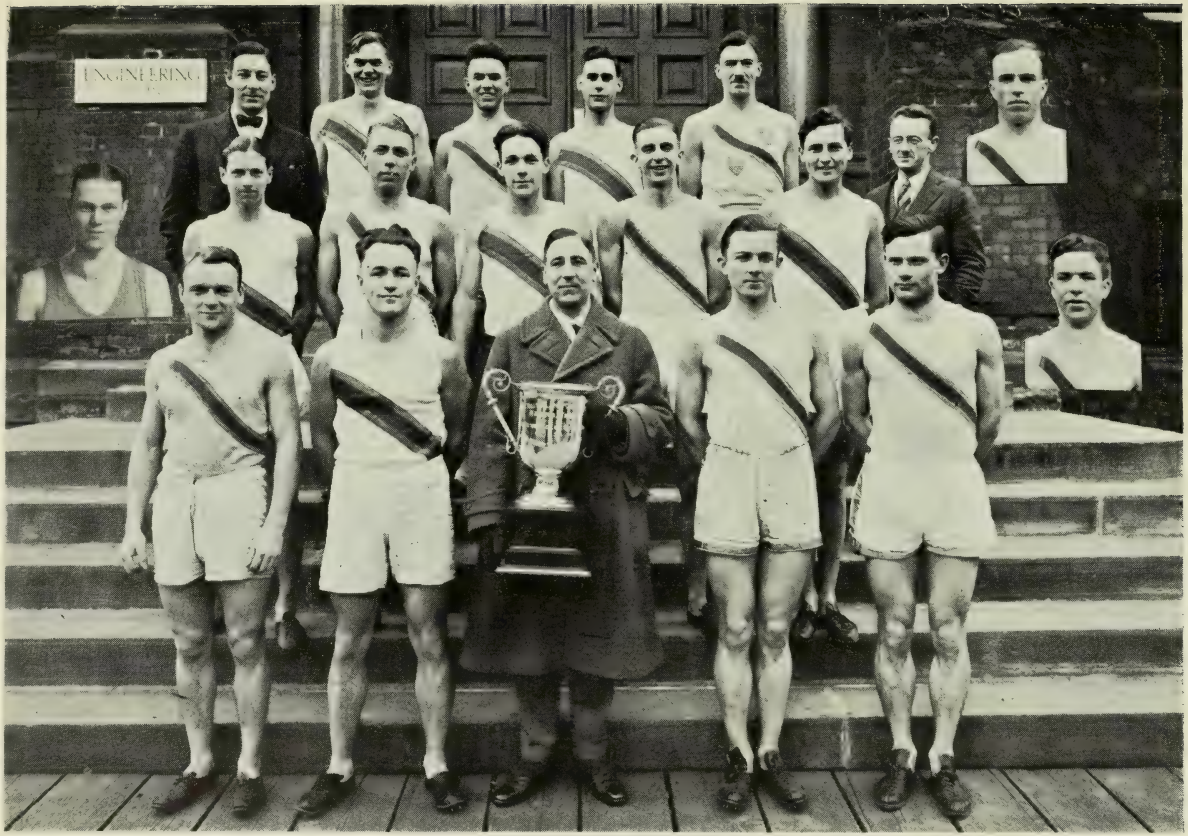
This success was made possible by the fact that large numbers of School men are interested in Track work and took part in the competitions. This is evidenced by the fact that about 70 men took part in the various events comprising the Interyear meet, where 2T8 proved the winning year, with 2T5 second.

In the Interfaculty Meet the School entry numbered 31 out of a total of 92 contestants. Of these 16 won points and thus made a place on the School team. The individual championship was a tie between D. J. MacKenzie and C. F. Burke, each of whom obtained 9 points. The grand total of 71 points out of a possible 144 was School's score, with Meds the closest team, making 27.

Following last year's custom a School Track jersey was presented to each of the new men on the team.

The following men were picked for the Intercollegiate Meet at Queen's: McKenzie, Burk, Polack ,Morrison, Pollock, Turnbull, Millican, Turner, Thompson and Perry.

In the Indoor Meet held weekly on the Hart House track School ably defended the championship held for the four years that this Meet has been held. The Toronto Cricket Club Cup was the trophy won at this Meet and we hope that it will stay in the Old Red School House. As usual, the score showed S.P.S. well ahead of the other teams, scoring 85 points out of 127. The team was composed of 14 men, two of whom broke records in the Meet. Pollock lowered McAuliffe's mile time from 4 mins., 50 secs., to 4 mins.,



Top Row: K. L. Carruthers (Coach), D. J. McKenzie, H. P. Ruggles, D. L. Polack, W. L. Thompson.
Centre Row: A. M. Grant, C. A. Morrison (Manager), C. F. Burk, A. A. Somerville, C. A. Pollock, M. G. Evans (Coach).
Bottom Row: E. F. Connolly, J. H. Russell, Prof. E. A. Allcut (Hon. President), A. D. Turnbull, S. W. Perry (President).
Insets: W. I. Turner, J. F. Millican (Hon. Vice-President), J. H. Ryan.

39 secs., and Cade's ½-mile from 2 mins., 14 secs., to 2 mins., 5 secs. Perry also clipped 1/5 second from his former 220 yard record, making it 24 seconds.

Other Meets were participated in during the year, namely, the Ontario Indoor Championships at Hamilton, the Indoor Meet at the Coliseum, and the Y.M.C.A. Indoor Championships at Central Y.M.C.A. In all these S.P.S. took a prominent place on the Varsity team.

Track men granted S's this year were: Burk, McKenzie, Russell, and Vercoe.

In closing my best wish for the S.P.S. Track Club is that it may receive the hearty co-operation and the interest of School men in all its activities. With such men as Russell, Mackenzie, Pollock and Morrison to fill the places of those who are leaving, the prospects for a successful future are rosy indeed.

S. W. Perry.

The Boxing, Wrestling and Fencing Club

The activities of School's B.W. & F. Club this year have been, in the main, the development of new and promising material. The graduation of McGuire, Seabourne, Relyea and their associates left School with no first string men of outstanding ability to carry our colours into the fistic arena, so it has fallen to the class of 2T5 to set some kind of example and stimulate the younger generation to prowess on the mat and in the ring.

As if the duties of President of the Athletic Association were not enough to keep two ordinary men occupied, Al. Jeckell stepped out in front and once again attached himself to the Intercollegiate belt. He was in top form this year and had no trouble disposing of the best Queens and McGill had to offer. He was mainly responsible for the development of the only other School man on the Intercollegiate team, A. C. Lee, who showed that he has a rosy path ahead of him, although he had the misfortune, after winning the School, Junior and Senior Assaults, to have his collar-bone broken in the Intercollegiate finals. It was tough luck, but having two more years, A. C. will have the 135 lb. Wrestling belt tucked away for us yet.

Ted Hubbard had the hardest luck of all. After endeavouring to make his usual 118 lb. this year and finding it extremely difficult,

he resigned himself to the step to the heavier class; but, feeling in top form, he ran off some of this weight at the last moment for the Senior, found he couldn't make it, and then had to fight 126 lb. class in a weakened condition. Graham of Arts had the good fortune to be handed the decision over him, and a very close decision it was. Ted has the consolation of having won the Intercollegiate 118 lb. last year.

Stevens, Toye and Lloyd were at the game on and off this year, and while they did not reach the top rung of the ladder, they helped keep School on the map. Art Toye tried Hub's game of taking off weight and while he made 126 lb. for the Senior he was put out.

The School Assault was a decided success this year and the multitude of entries shows that School is not wanting in boxing enthusiasm. Second year won the cup with third year close on their heels, first year, third and fourth year bringing up the rear, probably because so many of the latter were ineligible owing to previous wins in junior and senior company. The results of the finals were as follows:

Boxing

112lb.	Sankey,	2nd year
118lb.	Grant,	3rd "
125lb.	Hayward,	2nd "
135lb.	Wolfe,	1st "
147lb.	Loscombe,	1st "
158lb.	Ramsey,	3rd "
175lb.	McKenzie,	1st "
Heavy Weight—	Ruggles,	2nd "

Wrestling

118lb.	Irwin,	2nd year
135lb.	Lee,	2nd "
147lb.	Bailey,	3rd "
158lb.	Delaplante,	2nd "
175lb.	Anderson,	3rd "
Heavy Weight—	Millican,	4th "

Fencing

Dyment, 1st year

The medals for the winners were presented by the Dean at the last meeting of the Engineering Society in December, on which occasion he complimented the following men on their success in the Junior Interfaculty Assault:

Lee.....135lb. Wrestling
Howard.....135lb. Boxing
Loscombe.....147lb. Boxing
Robertson.....112lb. Boxing

Dyment won the finals in Fencing though outpointed in the preliminaries, and showed excellent form.

Loscombe gives promise of being remarkably well able to fill the vacancy left on the Intercollegiate team by Martin, and if he improves at the rate he has this year, will doubtless be an Intercollegiate champion before his sojourn here is ended.

Howard is another two-fisted mitt artist, who should go far if he sticks at it.

School won the Junior Interfaculty Assault by the small margin of five points, and it is too bad that lack of experienced men prevented the acquisition of the Davidson Cup.

The graduating members of the B. W. & F. Club Executive take this opportunity of thanking the men of the lower years who have so ably assisted them in the attempt to improve the team and wish them every success in the Davidson Cup run next year.

D. S. Lloyd,
Mgr.

Rowing

School is in the top rank of the rowing game for good by the appearance of its past record. This year, with the resumption of interfaculty competition, we captured the interfaculty championship, entering two crews on account of the quantity and quality of material which turned out. There is very little time available to train men in the science of rowing, and it was coaching of a very rough order that was used. But after a week on the machines and a few days on the water it certainly looked as if School had a very fair chance of winning again as we did in 1921. Training was very irregular on account of trips of the M. and E. Club, but the men were conscientious enough to go down on those chilly mornings at six-thirty, and that kind of spirit is bound to win.

As luck would have it the two School crews were drawn against each other. The only consolation was that we were sure of an entry in the finals. Crew No. II rowed the whole race with a broken seat and even then finished only a length and a half behind Crew No. 1. They were all green men except stroke and seven, and deserve a great deal of credit for such a game exhibition. Crew No. 1 had two experienced men in stroke and seven and also had men who had been in a work-boat before.

In the semi-finals our crew defeated Arts II crew by about five lengths and immediately had to set out to row Arts I, who had beaten Victoria in the previous race. Both crews got away to a very fine start with School slightly in the lead. U. C. used a shorter

Rochester (Stroke), Fisher, Clark, Heron, Shaw, Ruggle, Shey, Douglas (Bow)
Smart (Cox)

faster stroke which proved their undoing. The long, steady pull of the School crew kept them in the lead all the way and although Arts challenged with a wonderful sprint when about a quarter to go, School's lead and staying power kept them two and a half lengths to the good at the finish.

This is School's second victory in rowing and should be the start of another field of sport of the finest quality for Science men to take part in.

The personnel of the crews was as follows:

Crew I—Rochester, Fisher, Clark, Heron, Shaw, Ruggles, Skey, Douglas.

Crew II—McQueen, Seibert, Lilly, Jackson, Anderson, Campbell, Boehm, Griffith.

GEORGE SMART,
President.

Swimming and Water Polo

School has been a little unfortunate in the last two years as regards to swimming. With the graduation of 2T3 we lost the nucleus of the swimming team. By the time 2T4 passed out, so did most of the swimmers. Thus School was forced to compete for the Fitzgerald Cup (Interfaculty swimming trophy) with a new, inexperienced team. Everybody performed creditably, considering they were opposed to the best swimmers in the University.

Chorolsky distinguished himself again by breaking his own Interfaculty record for the 100 yard breast stroke. He also represented the Varsity swimming team in this event in competition against McGill University. Shortreed, the School long plunger, also on the Varsity team, made Vernot of McGill break the Canadian record for the long plunge in order to obtain the verdict.

The following fish also took part in aquatic activities: S. M. Jones, W. Enouy, C. Booth, A. J. Hill, E. Chorolsky, I. Lorenzen, and J. Shortreed.

The men remaining should form a good swimming team next year, and with the addition of new members are bound to go a long way in the next Interfaculty Swimming Meet.

A. J. Hill, Manager.

Basketball

In keeping with the efforts of all teams to bring honours to School in Interfaculty competition, School's two basketball teams had eyes on the Sifton Cup right from the beginning of the series.

The record of each team is unique. Both won in their respective groups without a defeat. Each won in the semi-finals, although Sr. School had to play three games against Wycliffe to decide the issue—and both teams met in the finals—which has seldom happened in any sport.

The final game was played March 27th, and the result showed that the aggressiveness of the Juniors was no match for the Seniors' experience; and for the first time in the history of the Sifton Cup Sr. School were declared winners. The team was composed of the following: Forwards, D. W. Dow (Capt.), W. I. Turner, E. G. Davies, D. J. McLean, E. M. Little, L. Grime; defence, W. O. Sorby, T. H. Patterson, C. A. Armour.

F. J. Milne, Manager Sr. School.

Indoor Baseball Club

Due to the lack of starting ability in the baseball line School have now to content themselves with seeing the 1925-26 session ushered in before they can hope to have the Spadling Cup rest in the "Little Red Schoolhouse".

The faculty grouping of teams this year affected School as follows:—Group I. Jr. Arts, Victoria and Jr. School; Group 2. Sr. Arts, St. Michael's, Dents and Sr. School.

In their group Jr. School, ably managed by Gord. Holden, put up great opposition to Arts and Vic, Vic finally winning the group, to be later eliminated in the play-offs by Jr. Meds. Jr. School lined up as follows:—Burns, G. Smith, Edmonson, Holden, Somerville, Hanks, Hillier, Irwin, J. George and Skey.

Senior School were a little more fortunate in their group, but fell one short of realizing their ambition of eliminating Dents. Sr. School finished next to Dents, the 9—5 and 7—6 defeat to the tooth-pullers marring their otherwise clean sheet. School were unfortunate in that their crucial games came at a time when Little, the regular moundsman was laid up with a badly sprained ankle.

Turner substituting, however, turned in three nice exhibitions, his only loss being a 7—6 defeat to Dents.

The Seniors lined-up several "old-timers" who were regulars from their first year. Here's the team:—Little, Lloyd, Turner, Teagle, Morrison, Dillane, Hill, Menzies, Limage, Inglis, Legge, Auld.

At the time of writing O.A.C. have eliminated Dents in the play-offs and Jr. Meds have disposed of Vic, so that in the coming week Jr. Meds and O.A.C. meet in the finals.

Next year I hope that the managers of the respective Junior and Senior teams will be appointed earlier, so that there will be time for the necessary work of rounding up men and arranging a little serious practice. This is all that is necessary for the reception of Mr. Spadling's Cup, as A-1 baseball material is at hand.

Best of luck for 1925-26.

W. G. Lloyd, Manager Sr. School.

Tennis

Before reviewing the past year's activities in tennis, I would like to say a few words about the game itself.

As far as I have been able to ascertain, lawn tennis is essentially a modern pastime, its origin dating back about fifty years ago. Its genealogy is rather obscure, but like all other games, that it had antecedents there can be no doubt or question.

The first of these is said to be a game known as "lusco pelaris" to the ancient Romans, and in which a ball was struck or tossed from one point to another for sport.

In Europe, we find it appearing and developing into court tennis in the Middle Ages, being the sport of royalty only, though later the property of the masses.

In Italy it was known of as "guioco della polla" and in France as "jeu de paume".

Enclosed courts were then built and the outdoor game was then known as "la longue paume" in France, and "pallone" in Italy.

One author claims that the French outdoor game is the most direct antecedent of our game. It was played wtih a cork ball struck, either with the bare hand or in some cases a gloved hand, over a mound of earth about two feet high. Later crude wooden rackets were devised with gut strings and in this form the game

was introduced into England, and a record of "field tennis" about the eighteenth century, speaks of it as a dangerous rival of cricket.

In the French game the server cried "tenez", and it has been suggested that the English have preserved the phonetic sound of the word and called the game tennis.

Apparently Major Walter C. Wingfield, a British army officer, invented lawn tennis as known to us, as he patruled it in 1874. He called it "sphairistike" or "play ball". It was played on a court shaped like an hour-glass, sixty feet in length and thirty feet in width at the base line and converging to a centre net twenty-one feet wide. The net itself was seven feet high at the ends and four feet eight inches at the centre. The method of racket scoring was used and service was played from a space in the middle of the court.

These dimensions were later changed and in 1875 the length, as used to-day was set by the Marylebone Cricket Club, and in 1877 there was held the first all-England championship meet. Just before the meet the court was made rectangular and later in about 1882 we have the scoring and court dimensions of the present day.

From 1877 on tennis has developed steadily, new strokes being formulated and receiving prominence at particular periods, but they have not necessitated any major change in the game. However, the game of to-day requires a great deal of skill and is unquestionably a sport that is second to none in its all-round development of the body.

Last year we had a large entry list in the Interfaculty Meet and made a very creditable showing, but owing to the lack of funds we were unable to hold the faculty championship meeting as instituted in the academic year of 1923-24.

The time at which tennis is played, of course, has a tendency to keep the game in the realm of minor sports, but as soon as the authorities realize the real value of the game, it certainly is worthy of as much recognition as rugby, if you don't look at our institution as a commercial enterprise seeking profitable returns, better facilities for developing the game will be provided.

With these thoughts in mind, I would suggest that our own Faculty take some initiative and provide next year in their budget for the maintenance of a championship tournament.

C. A. Armour.

"T" Holders

Front Row—
E. B. Hubbard (Boxing),
G. W. Smart (Rowing),
W. O. Sorby (Rugby),
F. A. Sievert (Rowing),
A. D. Turnbull (Harrier).

Second Row—
K. A. Kirn (Gym),
R. A. Fisher (Rowing),
E. Chorlosky (Gym),
H. Vernon (Rowing),
S. W. Perry (Track).

Third Row—
W. G. Lloyd (Rowing),
N. G. Scott (Rowing),
C. A. Pollock (Rowing),
C. A. Morrison (Track),
H. M. S. Pentelow (Br. Rugby).

Fourth Row—
W. L. Thompson (Rowing),
W. S. Kirkpatrick (Rugby),
W. I. Turner (Track & Rowing),
F. J. Millican (Track).

Inset—
Left, A. W. Jeckell (Wrestling),
Right,
Prof. T. R. Loudon (Hon. Pres. S.P.S. Ath. Assoc.).

Billiards

This is a game which seems to have a natural appeal for School men. Properly played there are few more scientific and skill-requiring games.

The Billiard Room with its excellent equipment is familiar to all. There are at present two small billiard tables and one pool table. The remainder of the room is occupied by large standard size tables, six in all.

The "Major", or Staff-Sgt., H. H. Roberts, Royal Grenadiers, is known to all. He is a crack rifle shot. In 1910 he won the Championship of Canada and has been on the Bisley team many times.

School has done well in Billiards this year. W. T. Burns won first prize in the Open Billiard Tournament last Fall, defeating the best players of the University in even competition, G. H. V. Belyea won second prize. W. T. Burns won second prize in the Snooker Tournament, and W. H. McCullough third prize.

G. H. V. Belyea won first prize in the Ladder Handicap Tournament, and W. T. Burns won second prize. This tournament extended for 10 weeks, from the middle of January to the 21st of March. It was a real test of Billiard ability.

The final results of the Handicap Elimination Tournament are not yet available. The winner holds the championship of the University for one year, has his name inscribed on the trophy in the trophy case, Hart House, and receives a sterling silver replica. The runner-up also receives a cup. School is represented in this tournament by P. Wigle, who plays J. C. Jack of U.C., in the semi-final. The winner plays N. R. McConkey in the final.

An exhibition match was held in the big gym Tuesday, March 3rd, between Stevenson, former World's Champion, and Cook, the Ontario Champion. Stevenson spotted Cook 300 points and won 800— .

The success of this exhibition was largely due to the efforts of "Jack" McNiven, 2T2 School Grad. member, who was in charge of the sub-committee, ably assisted by A. E. Beaman, 2T5, and C. H. Riches, 2T7.

The aim of the committee has always been to encourage the playing of English Billiards, and to try to provide the best equipment and operation of the room possible. Any complaints or suggestions are gladly received.

J. D. Burbank, 2T5, Secretary Billiard Committee.

U. of T. Rifle Association

Another successful year for the University of Toronto Rifle Association is nearing a close.

The Association dates back to 1904. During the war all Canadian Civil Rifle organizations were inactive, and it was therefore not until 1920 that reorganization began.

Outdoor shooting commenced at Long Branch in October and lasted until the early part of November. All shooting was done at the ranges of 200, 500 and 600 yards, the .303 Lee-Enfield rifle being used. These rifles, as well as ammunition and all other requirements, were supplied us by the Dominion Government.

The success of this year's outdoor rifle competitions was largely due to the interest that Major Ulton, from the Militia Department here, took in the Association. In the outdoor Canadian Inter-Collegiate rifle competition of 1924 the Varsity team, on which were three School men, ranked third, five teams in all having competed. A fine silver medal was given to each of the eight men who made the team. For the first time since the war the University of Toronto Rifle Association competed in the Imperial Universities' Rifle Match held on October 31, 1924. S.P.S. was again represented by three members on this team. Weather conditions during the match were very unfavourable. The Secretary has received no word of the team's standing on the writing of this report.

Dents won the outdoor Inter-Faculty match and with it the DeLury Shield, which last year was held by School. Professor DeLury is donating pins to each member on the winning Inter-Faculty team.

The Association is the proud possessor of the Hart House Indoor Rifle Ranges, which are the finest of its kind, as outdoors the .303 Lee-Enfield Rifle is used with gallery practice ammunition. This indoor range offers to many students, and especially to School men who cannot spare the time to go to Long Branch in the Fall, a real opportunity to perfect their marksmanship. Facilities are even better this year than ever through the untiring efforts of Captain T. E. Hayhurst, who installed a new lighting system in the ranges.

School have 37 out of 125 members on this year's Rifle Association, which is an increase of two over that of last year.

Shooting on the Indoor Ranges started the latter part of November. Varsity won the first Inter-Collegiate indoor match, being two points up on R.M.C. with two more matches which have yet to be shot.

Keener interest should be taken next year in Inter-Faculty indoor shooting owing to the fact that Dean Mitchell has promised a fine cup for annual competition.

RESULTS OF CANADIAN INTER-UNIVERSITY OUTDOOR RIFLE MATCH

Queen's University R.A	734
University of McGill C.O.T.C	716
University of Toronto Rifle Association	688
University of Manitoba C.O.T.C	667
University of Alberta C.O.T.C	637

A. A. SOMERVILLE, Sec.-Treas.,
U. of T. R.A.

Chess

The chief officers of the U. of T. Chess Club for the session 1924-25 are as follows: Honorary President, Principal M. Hutton; Acting President, W. H. Coulter, S.P.S. IV; Secretary-Treasurer, L. J. Harris, Arts III; Graduates' Representative, C. E. H. Freeman; Staff Representative, Dr. R. D. Rudolf; S. P.S. Representative, J. D. Burbank, S.P.S. IV; Team Captain, J. P. Dandy, B.A.

The "raison d'etre" of the Chess Club in the University is to provide a source of entertainment for those students who like to exercise their mental skill along mathematical lines or to give expression to their genius in some tangible form. The Club also serves as a school for the instruction of less fortunate men who desire to become acquainted with at least the general principles of the game, and who require a more or less intimate contact with more experienced players in order to accomplish this end. The Club also fulfils an important duty in bringing the staff, graduates, and undergraduates closer together, and to give the occasional student a chance, perhaps, to even up the score with one of his Professors in more favourable surroundings than the lecture room.

This year a new development has occurred in the club, *i.e.*, the inter-university matches. Such matches bring the different universities into closer contact, and understanding with each other, in a much different way than is done by rugby and hockey matches, or other sport or athletics. The reason for this is the type of man who constitutes the team. A chess player is naturally a deep thinker, and the exchange of ideas occurring at such functions is along different lines than those at athletic meets, etc.

Chess received a rather severe set-back in Toronto this year

due to some misunderstanding in the formation of the City Chess League, as this worthy body failed to materialize. Due to this a great deal of interest usually shown to the game was lost, and it seems that no other substitute, *i.e.*, impromptu matches with other clubs, or amongst the members of our own club, fills the gap or gives rise to the same degree of enthusiasm.

A type of chess which was unusually popular this season, (probably due to the absence of any league games) was in the shape of simultaneous games. Both Mr. Morrison, the Dominion champion, and Mr. Gale, ex-Dominion champion, gave exhibitions at the Club, and some very interesting chess was developed at these matches.

The Theosophical Society again challenged us to a friendly match, which resulted, fortunately, the same as last year.

Probably the most important events of the season were the two inter-university matches, with the University of Pennsylvania, and the University of Buffalo. These matches were held at Buffalo the first week in February. Although our team was successful against Buffalo, matters did not shape so well against Pennsylvania, and we were enabled to extract only one victory of the four games played with them. Further university matches are expected to develop next year, and it is hoped a little more publicity will be devoted to them.

An undergraduates' open tournament is run every year, with prizes to the winner, runner-up and best novice. This tournament is always a success, and brings out the relative merits of the members, as no other function could possibly do.

It might be well to point out the rather unpleasant fact that the ratio of School men to Arts is considerably lower this year than last. It is generally considered that at least a plurality, if not a majority of the members, should be School men. It is hoped this little reminder will scare up a substantial quantity of School talent for next year, as its presence in the club is necessary to prove that School still excels in all sports—physical or mental—outdoor or indoor.

W. H. Coulter, President.

THE ENGINEERING SOCIETY

University of Toronto

TRADING ACCOUNT

FOR PERIOD ENDING FEBRUARY 28, 1925

Sales		$9,246.22
Mdse. Inventory, April 1, 1924	$3,200.00	
Mdse. Purchases	7,232.26	
	10,432.26	
Less Inventory, Feb. 28, 1925	3,210.93	
	7,221.33	
Add Salaries	615.00	
	7,836.33	
Gross Profit to Profit and Loss	1,409.89	
	$9,246.22	$9,246.22

PROFIT AND LOSS ACCOUNT

Publications		$ 94.80
General Expense		427.87
Loss on Dinners		44.77
Loss on Dance		156.12
Grants		29.00
		$ 752.56
Balance Carried Forward		770.07
		$1,522.63
To Surplus Account		1,746.07
		$1,746.07
Gross Profit from Trading Account		$1,409.89
By Interest and Discount		100.67
Stunt Night		12.07
		$1,522.63
Balance Brought Forward		770.07
By Fees		976.00
		$1,746.07

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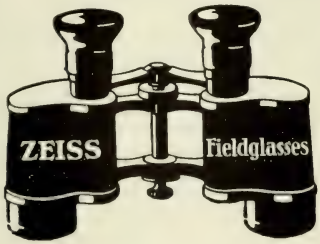

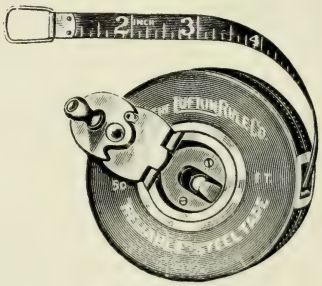

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